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GENETICS AND THE SOCIAL ORDER

Mark Graubard

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MARK GRAUBARD

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GENETICS AND THE SOCIAL ORDER

By MARK GRAUBARD

CHAPTER I.

Introduction

The theorizing habit of most philosophers of the Middle Ages has infected even the vast majority of modern writers in sociology, anthropology, philosophy, psychology and other social fields of thought. The tradition has become established that describing and verifying facts was an easy and unworthy occupation and that only those who could wield imposing theories deserved any attention and credit. It has never occurred to many modern writers that the generalizations they uttered and the theories they propounded had meaning only insofar as they could be tested in practice and shown to express actual relationship in nature. The result was that a good many pompous works were accumulated and great reputations created, but of actual knowledge little was gained.

A real understanding of the scientific method together with a certain freedom in its application would have put an end to that harmful practice. But before discussing the method of science we must analyze the approach to reality displayed by the general run of philosophers of the past and isolate their common faults. With that as a background it will be more instructive and historically more accurate to study the social and ideological changes that first, brought about the method of science, and secondly, were introduced by the application of that method.

Careful and responsible knowledge of reality was not considered indispensable for the making of philosophic theories. Idealist philosophers refused to recognize the fact that words were invented by man to symbolize real objects and events or definite relationships and concepts in the world of reality, and that consequently words could not be used without regard to that which they symbolized. Philosophers would coin all sorts of words and phrases, use them in a broad and loose manner without careful and strict definition, and weave them freely into theories that were intended more for æsthetic or moral purposes than for a concise generalization of experience. In addition, these theories were tied together into what was called a *system,* invariably full of moral and *a priori* assumptions that had neither validity nor practical meaning and the formulation of which was completely swayed by the social and religious beliefs prevailing at the time.

Essentially, it is easy to see, that philosophy was and still is an attempt on the part of man to understand the universe and man, especially the relations of man to man, to society and to nature. Idealist philosophers of the past exploited this field of human thought more for the sake of defending certain accepted socio-philosophical concepts than for analyzing them. Consequently philosophy became a playground where mental acrobatics, obscure sophistry and theorizing stunts were resorted to in order to reach more or less the same moral and social objectives by as devious or "original" a vocabulary, and subsequent manipulation of it, as possible.

The method of science employed an entirely different approach. It was developed in the era of commerce and industry where a knowledge of the forces of reality could not be replaced by abstract theorizing untested in and unconcerned with reality. It was necessity that forced man to abandon the making of irresponsible theories concocted for one *a priori* purpose or another in a wholly fantastic, imaginative manner. By imaginative we mean combining events or generalizations through disregarding entirely actual relationships as experienced in practice.

The making of theories for the sake of their æsthetic and moral appeals was possible in slave or feudal societies where social production of goods was static, insofar as a class of people, slaves or serfs, were set aside to perform all necessary labor. With the development and spread of commerce and industry this static attitude towards thought disappears because the socially powerful group of merchants and industrialists now requires more knowledge in order to wield more control over nature. A Liverpool shipbuilder, a Manchester cotton goods manufacturer or an Amsterdam merchant could not afford to make vague theories about nature with the carelessness and ease of a Hebrew shepherd or medieval monk. Industry and commerce brought about a realism which necessarily developed the method of science and its findings.

The method of science begins with a careful study of facts, and with accurate definition of terms. It realizes that a fact is an event in the external world intercepted by man with the aid of his sense organs. Because the majority of human beings have similar or even identical sense organs there is bound to be agreement on facts. When no agreement is reported it is clear that more examination is needed.

In the process of man's evolution on earth he accumulated many factual observations in a desultory, uncoordinated manner. Soon, however, we notice in him a tendency to generalize. This capacity to generalize, which man seems to possess to a degree unparalleled by any other animal, is definitely the mightiest weapon in his survival. It constitutes, in fact, the chief distinction between man and other animals. It is by means of this capacity to generalize that man accumulates information about the world and himself and learns from past experience shortcuts for the future and methods of controlling nature to serve his ends.

A generalization coordinates and unifies apparently unrelated events and brings to the fore the significant relationship rather than the particular object, time and place involved, in any particular case. Stressing the relationship makes possible substitutions of time, place and object. Thus, the observations that an apple falls to the ground in the kitchen with an acceleration of 32 feet per second on Monday, that a shoe falls to the ground in the street with the same acceleration on Sunday morning, etc., are generalized into a statement that all bodies fall to the ground with an acceleration of 32 feet per second. Here, objects, place and time are omitted. Consequently, the making of predictions is a necessary property of generalizations, since particular time is immaterial and any value for the time factor can be employed.

A scientific theory is a generalization which unifies many observations by suggesting a mechanism common to the events it attempts to explain. It is obvious that a theory, like any other generalization must account fully for all facts within its scope as known at the time, it must make verifiable predictions and must also account for exceptions by suggesting reasons for their being so modified as not to obey the generalization.

Here we come to the crux of the method of science. The primary ruling element is the *fact*. Theories are servants, made by man for convenience as a short cut in comprehending the past and applying the lesson to the future. Theories, as stated before, are man's most powerful weapon in his struggle with nature, in his struggle for survival. Like a tool, they are discarded when no longer serviceable or when conditions arise which necessitate a change in mode of attack. Should research reveal new facts or uncover hidden aspects of old observations we change the respective theory without tears and lament. The chief point in scientific thought is that theories are tools to be dismissed when found obsolete and to be replaced by more effective ones that may offer themselves. The master is our knowledge of reality as constituted at the time.

We can easily see, then, where the method of science differs fundamentally from that of idealist philosophy, which dealt exclusively with vague theories and moral principles and was little concerned with the quiet, laborious study of reality conducted by science. Philosophers used words that were never defined in operational terms and represented nothing tangible in reality. Their theories were never forced upon man by necessity as the only possible generalization of the known facts, and surely no effort was ever made to test them as well as the contrary suggestions, so as to definitely exclude the inadequate ones.

The extensive use of the method of science justifies the following generalization of procedure. It tells us that the first prerequisite for philosophizing is knowledge of reality, particularly of the field that we want to philosophize about. It also tells us that we must talk as little as possible about things of which we know nothing, but on the contrary try to abstract and isolate as many sound generalizations from the little we do know. We must not allow personal interests to influence our adherence to one theory or another even though that is obviously impossible in many fields of thought dealing with social, economic, moral and political problems. Recognizing the operation of such subjectivity means already accounting for it in our analysis. Under all conditions reality alone must determine the correctness of one theory or another.

In spite of the fact that our age is called by many the age of science (it is also referred to as the age of insects by paleontologists and the age of electricity by engineers) it can easily be demonstrated that in many spheres of thought the scientific method does not prevail but, on the contrary, the irresponsible theory-making habit of medieval philosophy. There are subjects in which the method of science is not employed, in which facts are paid little attention to, vague terms never defined and, in the manner of old philosophers, theories advanced in defense of accepted notions rather than as inevitable generalizations of carefully examined facts. It is not that the method of science cannot be used in the spheres under discussion, but rather that these fields are permeated with bias and few investigators are free to study them scientifically.

Such a state of affairs exists in all sciences that are in any way connected with social phenomena where class interests predominate. Because of the structure of our social order where the state is in the hands of an exploiting class which also controls social psychology, morals, ethics, æsthetics, etc., there are difficulties laid in the way of those who are honest investigators in their field and who reach scientific conclusions contrary to the interests of the ruling group. As a rule, those who are obliged from the start to prove certain economic theories because they are advantageous to the powers that hired them, cannot be scientifically free. Consequently, under capitalism all science connected with social, economic, moral or ethical problems is not free but enslaved, insofar as obeying the rules of the scientific method and reaching theories dictated by reality, not by the ruling class, is severely punished, in an indirect manner in the non-fascist countries, directly in those where fascism rules.

This vulgarization of the scientific method in the social sciences, whose function as defenders of our present social order could only be achieved by the reintroduction of the old philosophic method of thought, led many people to the erroneous notion that social sciences are not real sciences. They gave as a reason for it the fact that one cannot use a microscope and test tubes, perform accurate measurements, etc. No concept of science could be more naive than that and more replete with ignorance. Measurement is introduced in science only insofar as we need quantitive comparisons in terms of a common unit. In the descriptive stages of a science it is still possible to gather facts, organize them in a coherent, systematic manner and derive theories and laws from them. This process which defines a science can be utilized for a long time without the need for or possibility of measurement. It goes without saying that descriptive work invariably leads to the discovery of a unit with subsequent quantitive comparisons. Identifying measurement with science, however, is synonymous with misunderstanding the meaning of science.

The social sciences are thought by many not to be sciences only because of political vulgarization and corruption of them for the defense of vested interests. Should these sciences become freed by the abolition of class rule and class interest, they would be as easy or as difficult as the so-called "natural" sciences. Facts in one field require just as much study and checking up as in the other.

The only way of combatting current perversion and corruption in those fields of study which touch upon social relations and ideas, is by adhering to the method of science and by using its sound and compelling logic to break down distortion. This can only be achieved by familiarizing ourselves with the facts at issue and by strict avoidance of all idealistic confusion. The chief point is that we must ourselves most faithfully adhere to the scientific method if we want to expose and eliminate all loose thinking.

The social sciences deal with human beings and consequently with human behavior. Many economists, ministers, historians or philosophers are little concerned with the facts of biology when they propound theories intended to support the present economic setup. On the contrary, the more anxiety they show in upholding capitalist institutions, the more ignorance they display in whatever science they muster in their arguments.

Our concern is chiefly with the fields of heredity and behavior. So much ignorance and confusion prevail today in these fields that seldom do bourgeois thinkers have to labor hard in order to put over some utterly fantastic statement about "human nature," "racial traits," "instinctive behavior," "innate tendencies" and what not. No sooner are these phrases uttered by some professor, journalist, philosopher or politician, than most people retire into silence and acquiescence, as if confronted by some irresistible wisdom.

Not only from a scientific but especially from a social point of view are these theories of tremendous significance to us. Scientifically we know that beginning with false assumptions invariably leads to false conclusions and most often to expenditures of labor, doomed to failure. It is a fact that confused concepts of instinct, human nature and racial traits are not only filling the study of behavior with vagueness, but are definitely blocking all efforts at clarity. To put it mildly, the science of behavior will be at a standstill until all vague concepts are questioned and critically examined.

The same holds true for the social implications of the views involved. These are of the utmost importance in affecting the immediate lives of millions of human beings. There is only one weapon against falsehoood and hired preversion and that is continuous exposure of their inaccurate and unscientific basis, accompanied by lucid, scientific explanations of the experiences which the misleading theories attempt to explain. One must bear in mind that it is not enough to disprove certain false statements. It is necessary besides to offer a substitute hypothesis, if one is available, and show if possible why the wrong viewpoint was advanced and is being defended.

Our present society is a crucible in which fundamental economic reactions are taking place, sometimes at a slow rate and occasionally with explosive speed. These economic reactions and changes affect in an inseparable manner the entire network of social, moral, philosophic, scientific and cultural values. As students of this dialectical, historic movement of economic and ideological changes, living in this crucial period, we must prepare ourselves to do our share in combatting distortions of science and thought. This struggle for cultural progress against the forces of reaction and fascism can have meaning only if effected on a background of information.

Because of the difficulties involved in the task of attempting to clarify widespread but questionable hypotheses sanctioned by institutions of learning and the entire social setup, we have to be very much on guard not to expose ourselves to charges of fallacious reasoning or misinformation. To do that, as well as perform our job most effectively, we must familiarize ourselves first with the facts and with their proper scientific organization.

To many this is too laborious a venture. Because of the philosophic tradition many people do not mind participating in lengthy discussions of a general nature, but will persistently keep away from gathering real factual information which alone can form the basis for discussion. It is our task, after realizing the significance of sound and scientific knowledge of human behavior for any general discussion of social problems, to study the laws of heredity, the theory of the gene, evolution, mutation, race, reflexology, instinct and other relevant topics. Only on the the basis of such information can judgments be considered and arguments for or against certain philosophies be effective.

There are many revolutionary adherents who are so overcome by the powerful sweep and unifying scope of Marxism that out of sheer mental sluggishness they apply it like a mechanical formula, neglecting the necessity of a thorough factual foundation in the relevant field. That is a harmful procedure contrary to the very essence of Marxism, the very backbone of which is the scientific method. It is a procedure which essentially is and should remain the exclusive custom of bourgeois thinkers because they cannot face reality with a scientifically honest and free approach, but on the contrary, distort and pervert every aspect of it in order to uphold the system under which they live.

Let us then for a while forego facing the real big problems we are all anxious to discuss and concentrate our attention upon the unsensational and laborious process of learning and analyzing the humble facts of heredity, evolution and some biological aspects of behavior. In the process of accumulating this information the reader will find out for himself how indispensible these facts are and how treacherous it is to talk about "human nature," "instinct," "higher types," etc., in the absence of precisely such information.

CHAPTER II.

Laws of Heredity

We are familiar with the fact that many different characters exist within any given species of plant or animals. We also know that such characters may be inherited in the sense that they may be transmitted from parent to offspring. They may, however, not be so transmitted, as witnessed by the fact that colored rabbits may give rise to white ones and vice versa. Occasionally, two relatively similar-looking animals may give rise to a bewildering variety of types which seem to defy reasonable correlation.

These facts of heredity puzzled many students of biology as early as two hundred years ago. Many of them labored crudely in vain efforts to abstract some general scheme for the method of transmission of some specific character or other, but invariably gave up when confronted by the apparent chaos and the difficulty of getting a hopeful start. Even Charles Darwin spent many years breeding pigeons for that very purpose and in the end gave up in despair.

A successful beginning was finally made by an Austrian monk, Johann Gregor Mendel (1822-1884) who was the abbot of a monastery at Brunn and teacher of natural science at the city high school. The monastery was provided with a garden and greenhouse which enabled Mendel to take time off from contemplation of the holy trinity and devote his energies to a study of the inheritance of some specific characters of the garden pea.

In the introduction to his paper Mendel indicates quite clearly that he saw the exact reasons for past failures. These reasons were, *a*) failure to breed several generations, *b*) to record all forms in each generation, and *c*) to express these different types in their statistical relation. Keeping in mind these necessary prerequisites for a successful experiment he looked for proper material and found it in the garden pea. He obtained seeds of different types and grew them for two years to make sure that they were pure for the given character and that the characters remained constant. He finally selected seven pairs with which to do experiments. These involved seed shape and color, cotyledon color, pod type, pod color, flower position and plant stature. Peas are self fertilizing plants which means that the pollen from the anthers of a flower can fall on the pistil of the same flower, grow into it and fertilize the ovule. In many flowers called "cross-fertilizing" this is impossible and the pollen must come from another plant.

Mendel first crossed a tall plant with a dwarf one. He did that by protecting the pistil of one plant and removing its anthers or male organs. Subsequently, upon maturation of the flower, he brought the proper pollen in contact with the pistil. The seeds (peas) were examined, sown and the resulting plants recorded and counted.

Mendel observed that all the hybrids between tall and dwarf plants (tall was six to seven feet and dwarf three-quarters to one and a half feet high) were invariably tall, in fact a little taller than their tall parents. It made no difference whether the female parent was the tall one and the male dwarf, or the reverse, that is, in the reciprocal relationship. Mendel was struck by the fact that the hybrid was not an intermediate type, as is still commonly believed today, but resembled entirely one parent.

The significance of this observation became more obvious to him after he made crosses of the other pairs of characters at hand, such as colored and white seeds, hard and soft pods, yellow and green cotyledons, etc.

Characters are considered members of a pair when they are necessarily mutually exclusive. Mendel's plants, for instance, were either tall or dwarf, the pods were either hard or soft, etc. On breeding plants of the hard pod type to soft, Mendel found that all the hybrid offspring were hard. In the same way, when smooth was crossed to wrinkled the offspring was smooth, when colored was crossed to white the hybrid was white, and yellow cotyledon to green gave yellow, etc.

Mendel's second experimental step consisted of breeding the hybrid plants to each other, which meant that he crossed to each other the tall hybrids from the tall-dwarf cross. To his surprise he got a total of 787 tall plants and 277 dwarf, approximately a ratio of 3:1. The same held true for the other crosses. When the smooth hybrids or smooth-wrinkled were crossed to one another the offspring was 5474 smooth and 1850 wrinkled, again 3:1, etc. The identity of the ratio in every case indicated a common mechanism at work, responsible for the same behavior in each case.

The fact that pure tall plants bred for many generations produce only tall, but that tall-dwarf hybrid plants, though tall in appearance, produce one-quarter dwarfs when crossed to each other, gave Mendel the clue for a theory. It was obvious to him that one member of a pair of characters expressed itself fully in the hybrid, while the other was completely hidden from view but reappeared in the next generation in a quarter of the offspring. The character which expressed itself in the hybrid he called *dominant* and the other member *recessive*. Hence when two characters are crossed the hybrid or first generation will show either one parental character or the other. Whichever it is will consequently be called the *dominant* character

Mendel suggested the following theory. All characters are due to factors situated in the egg or sperm of the organism since these are the only agencies that can transmit them to the next generation. Each organism has a double set of such factors, but the egg or sperm contain only a single factor. These factors are dominant or recessive. They retain their identiy in the hybrid so that the recessive factor is not at all modified by its existence within a hybrid organism showing the character of the dominant.

The following diagram will make this point clear. Dominants are always represented by capitals, recessives by small letters, the same letter of the alphabet being used for any two characters that constitute a pair, regardless of their apparent structural differences. The symbol is usually the initial of the recessive character.

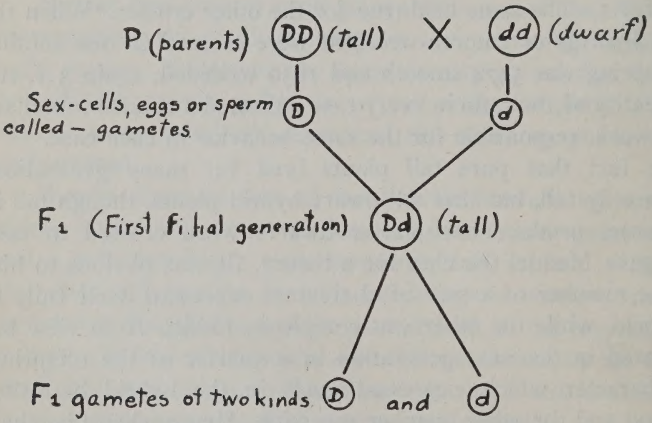

P (parents)
DD (tall)
X
dd (dwarf)
Sex-cells, eggs or sperm called – gametes
D
d
F1 (First filial generation)
Dd
(tall)
F1 gametes of two kinds
D
and
d

DIAGRAM Ia

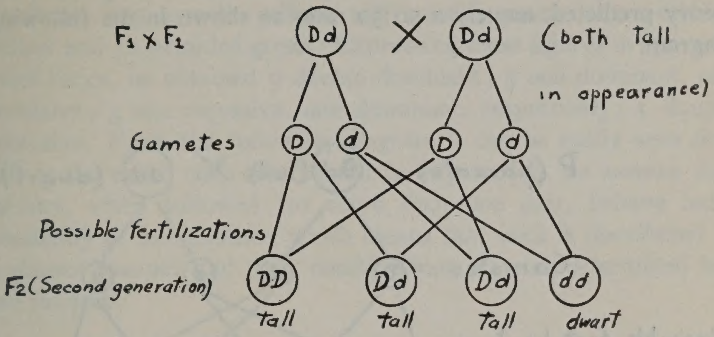

F1 x F1
Dd
X
Dd
(both Tall in appearance)
Gametes
D
d
D
d
Possible fertilizations
F2 (Second generation)
DD
Dd
Dd
dd
tall
tall
tall
dwarf

DIAGRAM 1b

This diagram indicates that in an organism in which both factors are the same (*homozygous*) all the sex cells, or gametes, are the same so far as the respective character is concerned. In a hybrid individual (*heterozygous*) half the gametes carry the recessive factor and half the dominant.

Fertilization is entirely at random and the results must be computed on a chance or probability basis. Thus in the *F1* x *F1* cross, a (*D*) pollen cell has an equal chance of fertilizing a (*D*) ovule as a (*d*) one. The same holds true for a (*d*) pollen. This accounts for the *F2* ratio which is exactly three dominants to one recessive, as obtained experimentally.

Mendel did the following experiments to test this factorial theory. He crossed all the tall plants of the *F2* generation and found exactly two-thirds to be hybrids and one-third to breed true, which proved his hypothesis. The dwarf plants of that generation behaved in every respect like pure dwarf. He further back-crossed a hybrid to the recessive and obtained exactly what his theory predicted, namely a 50:50 ratio as shown in the following diagram.

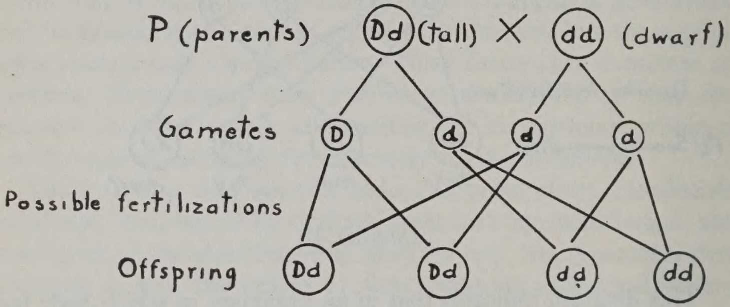


DIAGRAM 2

Mendel's hypothesis as stated so far constitutes his first law, also known as the law of *segregation,* referring to the segregation of factors in the hybrid. Mendel, however, went much further with his experiments and investigated the distribution and transmission of characters when parents differed in more than one pair of factors. He obtained plants which were both smooth and yellow and others which were at the same time wrinkled and green. On breeding the one to the other he obtained an *F1* hybrid that was smooth and yellow in appearance. This indicated to him that the dominance-recessives relationship for each pair was not affected by the presence of other characters.

On interbreeding the hybrids he obtained the following total numbers: 315 smooth yellow, 108 smooth green, 101 wrinkled yellow and 32 wrinkled green. Expressing these figures in approximate ratios, he obtained 9 double dominant; 3 one dominant, one recessive; 3 one recessive, one dominant, respectively; 1 double recessive. From the following diagram it can be easily seen that this is the exact ratio that should be expected if we assume that factors, when followed for more than one pair, behave independently of one another, which means that each is distributed in a chance manner and their combinations are not determined but are random.

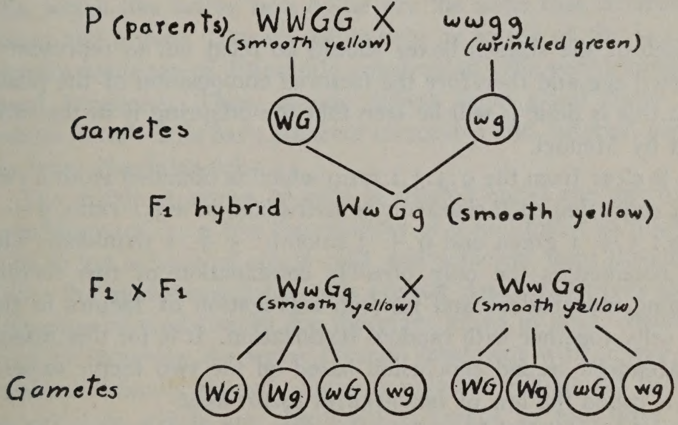

P (parents) WWGG X wwgg
(smooth yellow)
(wrinkled green)
Gametes
WG
wg
F1 hybrid WwGg (smooth yellow)
F1 X F1
WwGg X
(smooth yellow)
WwGg
(smooth yellow)
Gametes
WG
Wg
wG
wg
WG
Wg
wG
wg

DIAGRAM 3

The results can be best expressed by the following scheme.

Pollen → Ovules ↓	WG	Wg	wG	wg
WG	WWGG smooth yellow	WWGg smooth yellow		
Wg				
wG				
wg				

DIAGRAM 4

Each of the sixteen boxes should be filled out to represent a fertilized egg and therefore the factorial composition of the plant. When this is done it will be seen that the offspring is in the ratio found by Mendel.

It is clear from the 9:3:3:1 ratio which is obtained from a two factor cross that each character is distributed in a 3:1 ratio, 9 + 3 yellow: 3 + 1 green and 9 + 3 smooth: 3 + 1 wrinkled. The ratio obtained is the only possible combination of two factors assuming independent and random segregation of factors in the germ cells, together with random fertilization. It is for this reason that Mendel's second conclusion based on the two factor experiment is called the law of *independent assortment.*

Mendel published his results in 1866 and communicated them to the most prominent botanist of his time, Carl Nageli, who failed to see their significance. The principles he discovered were thus left in obscurity for many years largely because most biologists devoted then all their attention to evolution, and the presumed evidence for it in embryology, morphology, and comparative anatomy. In the year 1900, however, Mendel's laws were rediscovered simultaneously by three botanists, DeVries, Correns and Tchermak. His paper was subsequently rediscovered and its significance noted. In 1902 two English investigators, Bateson and Punnett, working with rabbits found that Mendel's laws applied to animals as well as plants. This would have served as a strong stimulus to genetic research if it had not been obscured by a hypothesis suggested at about the same time by Sutton working at Columbia University. Sutton's hypothesis became known as the chromosome theory and needs careful description.

It is a familiar fact that all living tissues are composed of cells, which like bricks in a house are the units that compose all tissues and organs. Tissues differ only by virtue of the fact that they are made up of differently constructed cells performing different functions. Thus, muscle differs from gland tissue only because muscle cells have different structures and different properties from glandular cells.

The visible structure of cells is studied under the microscope by cutting sections a few thousandths of a millimeter in thickness so as to get a layer of single cells and sufficient light through it. Under the microscope living cells are not structurally very clearly differentiated, and tissues are therefore killed in acid, chemically dried by removing the water through treatment with proper substances and finally stained. Staining involves dipping the tissue in several dyes which are chemically different so that they stain differently the various parts of the cells. Dyeing is a chemical reaction depending on the affinities of the dye and the material it is to act upon. It is well known that silk, wool and cotton do not as a rule take the same dyes because they are chemically different.

The same holds true for different components of the cell. By placing the cell successively in different dyes the cell can be made differentially colored like a map and in this manner demonstrate its complex and varied inner structure.

By means of this technique applied particularly to cells in the process of division it can be observed that each cell consists of a cell wall, cytoplasm and nucleus. The cytoplasm is the flowing viscous substance enclosed by the cell wall and surrounding the nucleus. The nucleus, too, is surrounded by a nuclear membrane. Within the cytoplasm are many formed bodies, some of known and some of unknown function, some permanent and some temporary in nature.

We are primarily concerned here with certain deeply staining bodies found in the nuclear substance and termed *chromosomes* or colored bodies. They are not as a rule visible when the cell is in the usual or so-called resting stage but make their appearance during cell division, to disappear again after division is completed. Their significance in the life of the cell became clear when it was established that no cell division takes place without their appearing on the stage and undergoing certain regular changes.

Just prior to cell division the nuclear wall breaks down and chromatin (darkly staining) threads appear in the nuclear area. They gradually elongate, then thicken, and after a while come to occupy a definite region in the middle of the cell in an equatorial plane. These bodies are called chromosomes. The chromosomes always lie in pairs and have regular and definite shapes and numbers when at that stage. They subsequently split longitudinally, each dividing into two, and then start migrating to opposite poles. At each pole of the cell there is at that time a focal point from which emanate lines and threads toward the chromosomes. These threads are called *spindle fibers* and are seemingly connected with the chromosomes and somehow involved in their separation. At each focal point there can as a rule be discerned a small element called a central body. The entire setup of central bodies, spindle fibers and chromosomes is referred to as a *spindle* because of its shape.

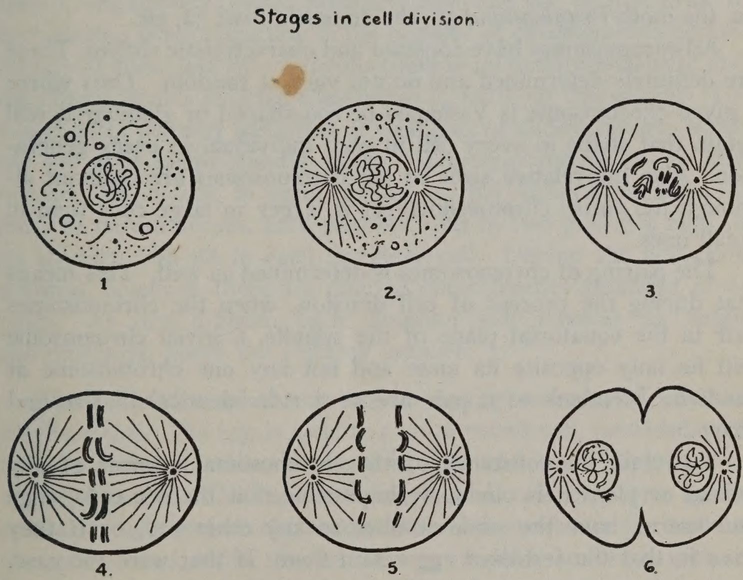

Stages in cell division

DIAGRAM 5

This diagram represents the chromosomal changes in cell division.

During the eighties and nineties of the last century a great deal of study was done on the chromosomes with the result that some exceedingly valuable information accumulated. The following are the most significant.

All plants and animals have a constant and characteristic number of chromosomes. This number is found in the nucleus of every cell in the body regardless of its shape and function. Thus, every cell in man has 48 chromosomes, the fruit fly 8, jimson wheat 12, the moth *Pragmatobia* 56, the domestic fowl 32, etc.

All chromosomes have constant and characteristic shapes. These are definitely determined and do not vary at random. Thus where a given chromosome is V-shaped or rod-shaped or globular it will retain that shape in every cell in each individual in every generation. Also the relative sizes of the chromosomes are constant although the entire chromosomal set is larger in large cells than in small ones.

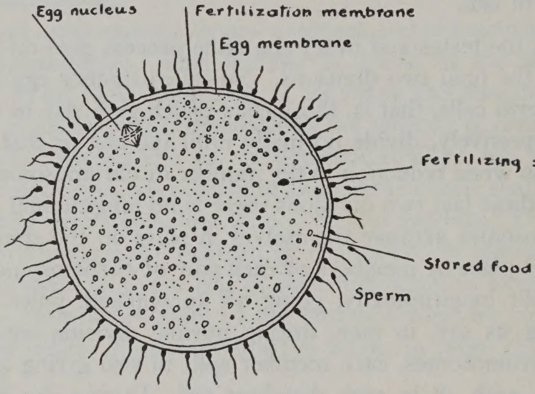
The pairing of chromosomes is determined as well. This means that during the process of cell division, when the chromosomes pair in the equatorial plane of the spindle, a given chromosome will lie only opposite its mate and not any one chromosome at random. Members of a pair are as a rule identical in size and shape.

To retain the constancy of the chromosomal number of any animal or plant it is obviously impossible that the sex cells, eggs and sperm, have the same number as any other cell, or if they have it, that the fertilized egg retain them. If that were the case, then each successive generation would double the number possessed by its predecessor.

This situation became clarified when van Beneden discovered the *reduction division*. It was stated before that during the normal cell division each chromosome split longitudinally and each member of such a split pair went to opposite poles. In this manner each ensuing cell has exactly the same chromosome configuration as its parent cell.

Within the testes and ovary the same process goes on for some time until the final two divisions. So-called mother egg cells and mother sperm cells, that is, those cells which give rise to eggs and sperm, respectively, divide normally until the last or that prior to last division when reduction in the number of chromosomes occurs. At one of these last two divisions there is no longitudinal split and the chromosomes arrange themselves in pairs on the spindle. Division takes place by members of each pair of chromosomes, which *are not* split longitudinally, going off to opposite poles. In this manner, let us say, in man, during normal division we have 24 pairs of chromosomes, each member split in two giving a total of 96 strands with 48 in each daughter cell. During the *reduction* division, however, there are only 48 chromosomes arranged in 24 pairs. At this division each daughter cell receives 24 single chromosomes, hence the reduced number.

The reduced number only occurs in egg and sperm cells and nowhere else. The egg is usually a large round cell, provided with nutrient material, while the sperm is small and mobile by virtue of a whip-like tail. During fertilization as a rule only one sperm enters the egg, and its chromosomes, which constitute the bulk of the sperm head, move toward the egg nucleus, and fuse with it. Each nucleus contains half the number of chromosomes, and fertilization is really achieved when the two half nuclei fuse and reconstitute the characteristic chromosome number. It is only then that the egg begins to divide and the embryo begins to develop. The cells of the embyro will obviously have the reconstituted full chromosome set.


Egg nucleus
Fertilization membrane
Egg membrane
Fertilizing sperm
Stored food
Sperm

FERTILIZED EGG AND SPERM. DIAGRAM 6

CHAPTER III.

Chromosomes, Heredity and Sex

From the nature of the reduction division and the reconstitution of the characteristic chromosome number by fertilization, it follows that every individual who has a given set of paired chromosomes, as, for instance, 24 pairs in man, receives one-half set from the male parent and the other from the female. The next important point is that these paternal and maternal chromosomes are not tied into a block but are free and independent in the offspring. This means that within the ovary or testes of the offspring it is not the maternal or paternal half set that goes as a block into one sex cell or another but that, on the contrary, the origin of the chromosomes plays no part. For example, within the cells of the ovary of a woman there are 48 chromosomes of which 24 originally came from that woman's mother and 24 from her father. Within the ovarian cell, however, they are all mixed and the egg may contain any 24 chromosomes at random, so that some of them will be paternal, others maternal, the ratios differing in different eggs.

It was this random nature of the distribution of chromosomes that suggested to Sutton the analogy between chromosomes and Mendelian factors. He consequently postulated what is known today as the *chromosome theory of heredity* which states that the inherited factors suggested by Mendel are carried on the chromosomes and that the random distribution of chromosomes agrees fully with the ratios obtained by Mendel and with the mechanism he postulated. Let us illustrate the example of the cross between tall and dwarf.

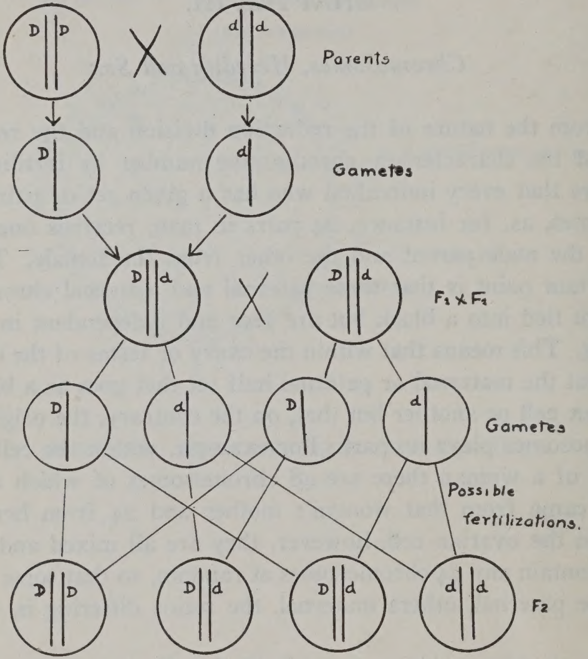

D
D
d
d
Parents
D
d
Gametes
D
d
D
d
$F_1 \times F_1$
D
d
D
d
Gametes
Possible fertilizations.
D
D
D
d
D
d
d
d
F_2

DIAGRAM 7

In this diagram we are only following the distribution of one pair of chromosomes. We see then that an organism has two Mendelian factors only because chromosomes always go in pairs, each having come from a different parent. The sex cells have one factor, as Mendel was forced to assume, only because the reduction division gives them one member of a pair of chromosomes.

In the case of the two factor cross, such as, between smooth yellow and wrinkled green, we are dealing with factors situated on two pairs of chromosomes. The cross would then be represented as follows:

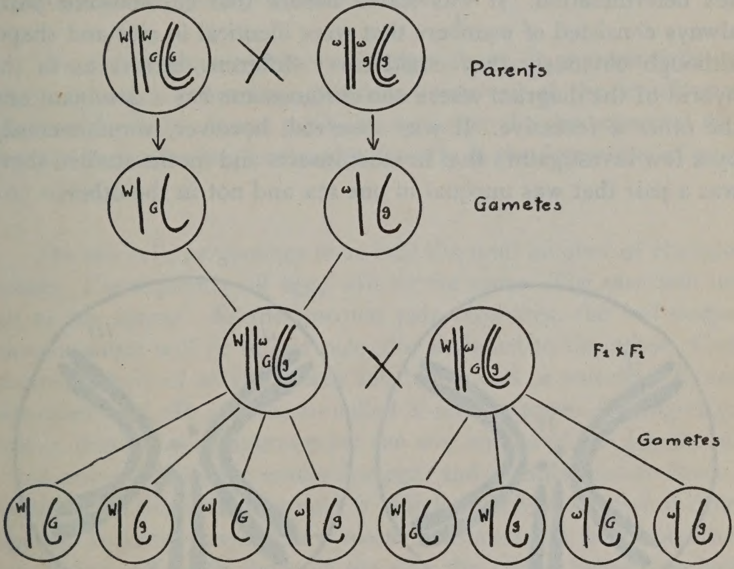
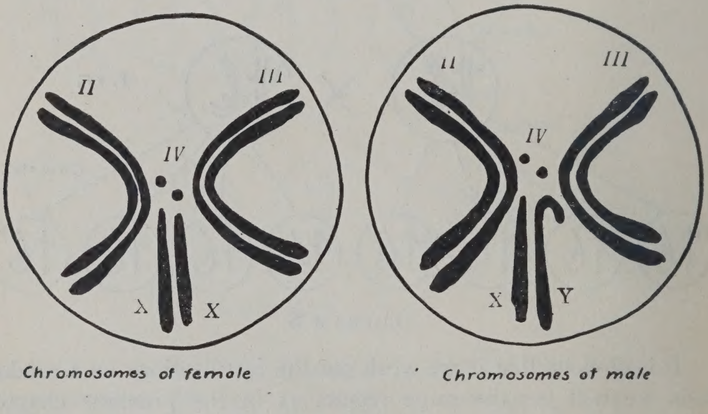


DIAGRAM 8

It is obvious that if we work out the fertilizations on a random basis we will get the same results as in the previous chapter, namely the 9:3:3:1 ratio that Mendel found. The only difference now is that the factors Mendel assumed are no longer imaginary figments suspended in the vague, but are postulated units that have a definite physical basis, namely the chromosomes, the observed behavior of which accounts fully for all the theoretical behavior of the Mendelian factors.

The chromosome theory of heredity gained particular support from a study of the so-called "sex chromosomes" and their role in sex determination. It was stated before that chromosome pairs always consisted of members that were identical in size and shape, although obviously they could carry different factors as in the hybrid of the diagram where one chromosome has a dominant and the other a recessive. It was observed, however, simultaneously by a few investigators that in most insects and moths studied there was a pair that was unequal in one sex and not in the other.



Chromosomes of female
Chromosomes of male

DIAGRAM 9

In studying the formation of eggs and sperm in the fruit-fly *Drosophila melanogaster,* for instance, it was observed that the same analogous pair of chromosomes was different in the male and in the female. While the female contained two pairs of V-shaped, one pair of dot-like and one pair of rod-shaped chromosomes, the male had the four V's, the two small round ones and one unequal pair which consisted of one rod, like those of the female, and one J-shaped chromosome.

The chromosome picture, as shown above, is characteristic of each sex and is present as shown in every cell of the female and male respectively. It can easily be seen that the chromosomal difference expresses itself most significantly in the formation of eggs and sperm.

The sex cells or gametes have half the total number of chromosomes. Consequently all eggs will be the same. The case will not be so for sperm. As the unequal pair separates, the rod-shaped chromosomes will go to one pole, the J-shaped to the other. Consequently half of all the sperm will bear a rod or so-called X, and the other half, the J or the so-called Y-chromosome. During copulation, thousands of sperm enter the sex organs of the female. In most animals only one enters the egg, and stimulates it to form a fertilization membrane around it which somehow keeps out other sperm. In other cases, many sperm can enter but only one fuses its chromsomes with those of the egg, the others being dissolved. In any case, it is purely a matter of chance which sperm fertilizes the egg first, the X-bearing or Y-bearing. This is simply another way of saying that fifty percent of all the eggs will be fertilized by X-bearing sperm and fifty percent by Y.

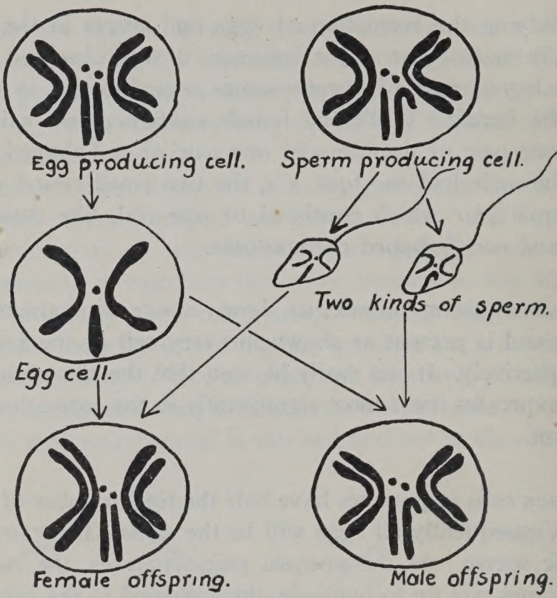

Egg producing cell.
Sperm producing cell.
Two kinds of sperm.
Egg cell.
Female offspring.
Male offspring.

DIAGRAM 10

Hence we see that sex is determined by chromosomes, and that the sex of a given individual is entirely a matter of chance. The pair of chromosomes involved are called the sex chromosomes.

The human species has forty-eight chromosomes in twenty-four pairs. In the male there is one uneven pair (XY), so that half of the male sperm will be 23 + Y and half 23 + X. All eggs are 23 + X. Consequently, sex determination in man is of the same mechanism as in the fruit-fly.

It should be stated that it is not the Y-chromosomes which make for maleness, because in the fruit-fly males are occasionally obtained which have no Y but only one X. Such males are, however, sterile. The Y-chromosome carries fertility factors the absence of which results in sterility.

It is not a rule either, that it must be the female that bears the even pair and the male the uneven one. In fowl, moths and butterflies, the situation is reversed. There, it is the male which carries the equal pair so that all sperm are alike, while half of the eggs will always be female producers and half male. To differentiate it from the previous mechanism, this set of sex chromosomes is described as ZW in the female and ZZ in the male. In some cases, the mechanism is XX for the female and XO for the male, where normally no Y is ever present.

In bees and wasps an entirely different mechanism seems to be responsible for sex. Eggs of the queen bee, the female, develop regardless of whether they are or are not fertilized. When the eggs laid are not fertilized, they develop into males (drones). When they are fertilized they develop either into workers or females, that is, queens. The males coming from the unfertilized egg have half the number of chromosomes, the workers and females have the normal paired set of chromosomes. It has been observed that in the testes, during the formation of sperm there is no reduction division, as was to be expected. Here, then, we have a case where sex is determined by chromosome number.

There are cases on record where the sex of the offspring depends on environmental forces, such as season. In most cases studied so far, however, determination of sex is basically chromosomal. The way in which chromosomes operate to bring about sex development can, as in all physiological processes, be modified by environmental, physical or chemical agencies. Let us consider such a case in mammals.

It has been known for some time that, in cattle, twins are occasionally born, of which one member would be a normal male and the other would resemble a female, yet be an intersex and sterile. Such irregular individuals were called *free martins* and were obviously sexually abnormal, in that they had mostly female and yet some male characters.

The problem has recently been thoroughly investigated, and it was found that in all such cases the free martin starts out as a female with an XX pair of chromosomes. The male is, of course, XY. An embyro is attached to the uterus of the mother by means of a placenta where the blood streams of mother and child come very close to one another, though they never mix. When the two placentas of a pair of twins are normal, the offspring is normal and one may be a female and the other a male, if their chromosomes are XX and XY respectively.

It so happens that occasionally the placentæ of two embryos, of which one is male and the other female, become fused so that their blood streams mingle. As a result of this contact, the sexual development of the female co-twin is so interfered with as to cause its intended ovary to develop like a testes. It has not been established that it is the hormone of the testes that causes the free martin or that the testes at that period produce a hormone at all. All that can be said at present is that the fusion of the two blood streams is responsible for the interference with the normal development of the female co-twin.

It should be noted that though the intended ovary of a free martin is entirely like a testis, there have never been any sperm found in it. Apparently the possession of an XY chromosome pair is indispensable for that. *Hermaphrodites,* or to use a more accurate term, *intersexes,* have been reported in man as well as many other mammals. They have as yet been little studied, but invariably the chromosome make-up is either male or female and the disturbance is glandular, and does not change egg into sperm formation or vice versa.

Intersexes occur with different frequencies in insects. In the fruit-fly *Drosophila,* hermaphrodites occur in which one side of the body is male and the other side female. This can be recognized by means of various structural characteristics and by sex-linked inheritance to be explained later. T. H. Morgan has suggested a sound explanation for such occurrences. The hermaphrodite starts out as a female with XX chromsomes. During the first division of the fertilized egg, one of the daughter cells loses somehow one of its X-chromosomes and is left with only one. As was stated before, there are some individuals that have no Y at all and only one X. They are males, though sterile. Hence in the case at issue when one cell has the full female complex and the other has only one X, the first, which is embryologically destined to give rise to one half the organism, gives rise to a female half and the other to a male.

It is also known that on rare occasions an egg occurs that has two reduction nuclei, due, let us say, to failure of the cell to divide after the chromosomes have separated. Such eggs are fertilized by two sperm. When one is X-bearing and the other Y-bearing, it is obvious that a hermaphrodite will result, the female part from the XX combined nucleus and the male from the XY.

In the wasp *Hubrobracon,* a different type of hermaphrodite appears, not longitudinally divided, but fore and aft. It should be recalled that in the wasp, sex determination is as in bees, fertilized eggs of full chromosome complex produce females, unfertilized ones of the half chromosome number produce males. In these hermaphrodites, as in *Drosophila,* one cell of the early two cell stage embryo gets by accident the female number, and the other cell the male. Unlike *Drosophila,* these two cells give rise to fore and aft parts and not right and left sides.

The behavior of these wasp hermaphrodites is of interest. The normal male is in many ways structurally different from the normal female and has many different habits. The male lives on sugar. The female has a sting in her abdomen and uses it to kill cornmoth larvæ in which it deposits its eggs.

A hermaphrodite with a male head and female abdomen behaves in every way like a male. Although such an individual is provided with a sting it will never use it, and will not at all be attracted to larvæ. It will live on sugar and pursue and court other female like a normal male. It should be added that the ovaries in the abdomen are normal and full of eggs.

A hermaphrodite with a female head and male abdomen behaves like a female. Although it is not provided with a sting it will descend on cornmoth larvæ and move its abdomen as if to sting them. It will not court females even though its abdomen has testes that possess sperm.

This indicates that sex behavior in insects is determined by the central nervous system, the brain, and possibly also by the external sense organs. It had been known from other evidence that glands and hormones play no role in sex determination of insects. It seems that a male behaves as a male because his sense organs are sensitive to odors or other stimuli emanating from the female and that the brain receives these stimuli and transmits them to effectors which, through their operation, effect what we know as male behavior. The same holds true for the female who, however, is not so much provoked by smells as by actions and movements of the male, as in courtship.

In mammals the situation is different. There, it is the chromosomes that determine whether the intended sex gland called *gonad* develops into either ovary or testis. Once that takes place, certain consequences must occur. The gonad produces hormones, either male or female, depending on whether the cells are XY or XX, respectively. These hormones in turn are carried by the blood and effect the development of the structures and functions of various organs. It should be remembered that hormones are not mystical entities working magic. They are chemical substances, in the case of the sex hormones of known composition, differing little from each other but bringing about widely varying consequences.

The function of such substances can obviously be modified by the internal and external environments, since theoretically every reaction can be so modified. Hence changes in the sex development reaction do not go contrary to the chromosome theory but when detected should be studied scientifically for the sake of revealing the actual nature of the sex reaction and the forces that modify it.

Intersexes occur also because of chromosomal abnormalities. Occasionally flies appear that have three X chromosomes because of one abnormal internal event or another. Such flies are females, but sterile and deformed in many ways. Losses of parts of the X chromosomes or extra chromosomes, not necessarily the X's, disturb the structural and physiological forces which determine the sex mechanism and produce intersexes or sexual anomalies.

In this connection it is relevant to mention that there are characters which express themselves differently in males and in females. Thus, *eosin* eye color in *Drosophila* is darker in the male than in the female. In cattle there is a coat color called *mahogany* represented by *MM* and its paired factor is red, *mm,* in both sexes. In hybrids, however, dominance depends on sex. A male hybrid, *Mm,* is mahogany and a female *Mm* is red. Hence, in the female, red is dominant and in the male mahogany. A similar case is the horned condition in sheep. *HH* individuals of both sexes are horned, and *hh* hornless; but the hybrid males are horned and the females hornless. This type of inheritance is called sex limited since the expression is modified by sex.

Another illustration is the case of plumage in birds. In this group, as is well known, it is the males that invariably have the colored plumage, singing capacity, and other characteristics we consider beautiful or desirable. The females are plain and dull in plumage and are songless. It has been found that the lack of coloration of the female is due to the sex hormone of the ovary. When that organ is removed the female feathers develop the same coloration as the male. Removal of the testes has no effect on the male. Hence, the normal tendency to produce coloration is inhibited by the hormone secreted by the ovary.

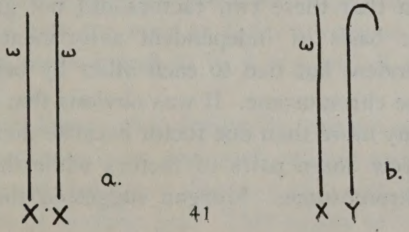
CHAPTER IV.

The Theory of the Gene

The chromosome hypothesis stimulated genetic research to a high degree and breeding experiments were started on many animals. At Columbia University, T. H. Morgan began around 1905 on his now famous experiments with the fruit-fly *Drosophila melanogaster,* and a few years later he found the first mutation, white eye. A normal fruit-fly has two prominent red eyes on either side of the head. When, therefore, an individual appeared with white eyes it could not help being noticed. The individual was isolated and bred so as to establish a line of white-eyed flies.

The factor for white eyes did not behave fully in accordance with Mendel's law and Morgan noticed that the distribution of the character for red eyes and white eyes varied with the sex of the parents who carried the recessive. As was stated before, this was not the case with Mendel's experiments. Morgan then suggested the hypothesis that the factor for white eye was situated on the X chromsome and that the Y chromosome acted as if it were devoid of any factors whatever, so that a female that had white eyes was in her makeup as in (a), and a white-eyed male as in (b).

DIAGRAM II



This hypothesis accounted completely for all the results obtained.

The sudden appearance of a new type, out of the blue, made Morgan and his associates, Sturtevant, Muller and Bridges look for more, which indeed appeared. Within a few years they accumulated many new types, affecting almost every visible character in the body such as wing shape and size, body color, eye shape, size and color, bristles, feelers, hair, etc.

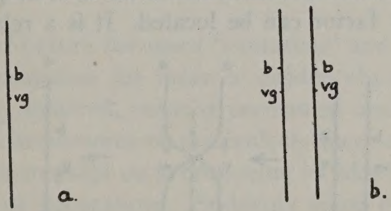
All factors that were not situated on the sex chromosomes, like white eye, obeyed Mendel's law of segregation. The law of independent assortment was also obeyed. When a black body colored and pink eyed fly was crossed to a gray colored and red eyed (gray and red dominant) the 9:3:3:1 ratio was obtained in the second generation, as was to be expected.

Just as white eye proved to be an exception to Mendel's first law it was soon found that there were many exceptions to Mendel's second law as well. A type had appeared which had extremely short wings and was called *vestigial* and was recessive to long wings. When a black vestigial fly was crossed to a gray long, the $F1$ was gray long as expected. When such $F1$ flies were mated to one another the expected 9:3:3:1 was not obtained but instead the original types, black vestigial and gray long, reappeared in about 86 per cent of the offspring.

In an effort to explain this type of behavior Morgan hit upon the brilliant idea that these two factors did not give the results expected on the basis of independent assortment because they were not independent but tied to each other by being located on one and the same chromosome. It was obvious that a chromosome had to carry many more than one factor because there were known then already a few dozen pairs of factors while the fly had only four pairs of chromosomes. Morgan suggested the term linkage to designate the condition when factors were linked to each other by being placed on a common chromosome. Independent assortment, as was pointed out in a previous chapter, exists only by virtue of the random and independent distribution of the factors. That, as we already know, can only be possible when the factors examined are situated on *different* chromosomes. When they are on the same chromosome they are linked, and one will always appear with the other.

There are exceptions, however, to the last statement. Black and vestigial are situated on the same chromosome, which was identified as one of the V-shaped pairs and called *II,* the X chromosome being designated as *I.* Diagramatically it is easiest to represent it as a vertical line.

DIAGRAM 12.



Morgan found that a hybrid female of the chromosomal constitution shown in the diagram below would produce a large majority of eggs either with the *b vg* or *B Vg* chromosome. A small number, however, were found to be *b Vg* and *B vg.* How did that come about?

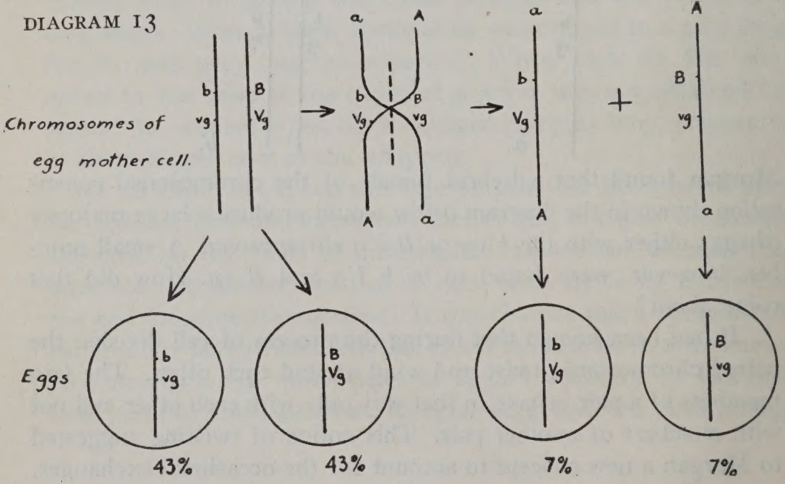
It had been known that during the process of cell division the paired chromosomes twist and wind around each other. The two members of a pair behave in that way only with each other and not with members of another pair. This notion of twisting suggested to Morgan a new concept to account for the occasional exchanges.

He termed it *crossing over.* It means that while the two chromosomes are intimately twisted around each other in the cell, a break may occur in a small percentage of cases, between the points *b* and *vg,* and, in the process of recombining, an exchange of chromosome pieces will take place with subsequent exchange of factors.

It should be noted that only a small percentage of eggs come from crossed-over chromosomes. That percentage varies with different factors and the hypothesis was suggested that the percentage of crossing over is an indicator of the actual distance betweeen two factors on a chromosome. This hypothesis has been amply borne out by the facts. The higher the percentage of crossing over between two factors, the larger the actual chromosomal distance between them.

On the basis of similar evidence it was also proved that factors lie on chromosomes in linear order and at present the exact position of any factor can be located. It is a relatively easy mat-

DIAGRAM 13



ter to determine whether a given new factor is on chromosome *II* or *III* or *IV* (DIAGRAM 9). If it is sex-linked it is on chromosome *I* which is the X chromosome, otherwise it is linked with those factors with which it fails to give independent assortment. Further, by the vlaue of percentage crossing-over between the factor in question and some accurately located factor, its exact position on the chromosome can be established.

In the fruit-fly, crossing over takes place only in the female and rarely if ever in the male. That, however, is no universal law because in the mouse and rabbit, crossing over occurs in both sexes. In addition, crossing over must not necessarily occur only once in a pair. Members of a pair may loop around each other more than once and occasionally cross in two, three or even four points of breakage. Above all, it should be clear that crossing over is a means of increasing types of combination of characters in offspring.

We have used before the word "mutation" and must therefore explain it. By mutation we mean a sudden change in a factor that, once having occurred, remains permanent and reproduces its like. On a given chromosome of the fruit-fly there was a factor for red eyes. This factor kept on reproducing its like for hundreds or even thousands of generations. Suddenly some event took place which caused within that factor a change of such a nature that the new one produced white eyes. This new factor will now go on reproducing itself for many generations until it too may undergo a mutation either back again to the old type or to some new one.

In *Drosophila* it so happened that the factor for red eyes mutated many times producing in all about twelve different eye colors, such as white, buff, ivory, eosin, cherry, blood and others. In this case, then, the concept of paired factors still remains, because any given individual can only have two factors of that series since it can only have two chromosomes of a kind and no more. This phenomenon of multiple products of mutation is of great value in telling us of the nature of the factors and of mutation.

While mutations were being eagerly sought for and found with a frequency of about one in every 200,000 flies raised and observed, there appeared independently mutant types, which, to judge by appearances, looked very much alike yet proved on genetic tests to be produced by different factors. The following illustration will clarify what is meant by appearing independently. In a certain series of experiments with the normal type fly, named *gray body,* an individual appeared which was darkly colored. It was isolated, found to breed as a Mendelian factor, and a pure line was established. This mutant race was called *black.* The factor for that character was located by means of genetic experiments and crossing over and was found to be situated near the midpoint of chromosome *II.* At another time, in fact much later, another series of experiments was being conducted on some different stock and a colored mutant appeared.

This new black mutant race resembled the early black one very much, but breeding with the first one produced the normal color or gray, indicating that different factors were involved and not members of the same pair. By means of genetic experiments the factor for the new black race was found to be situated on the right arm of the V-shaped chromosome *III.* Since it was produced by a different factor from black it was called by a different name, namely, *ebony.*

It is easy to see why the hybrid between black and ebony would be gray. The new characters were both recessives and due to different factors. The black race must be genetically represented as *bb,* carrying also the dominant to ebony, which is not ebony, that is, gray in appearance. The ebony race, however, will be *ee* and will carry the dominant to black *BB,* not black, that is, gray in appearance. The cross will be *bbEE* x *BBee* and the *F1* will be *BbEe* which will be gray, since each parent contributes the dominant to the character borne by its mate.

These considerations led Morgan to separate the concepts of factor and character. He realized that similarity of character did not mean identity of factor but, on the contrary, factors located on different parts of the chromosomes could produce almost identical characters. Mutation meant that a given factor could retain its position and yet change so as to produce a differently appearing character.

In consequence of this clarification Morgan postulated the *theory of the gene.* The term *gene* refers to the factor, no longer the vague Mendelian concept placed somewhere in the sex cells, but a concrete physical entity occupying space on the chromosome, capable of undergoing changes called mutations which produce modifications in the character involved. The chromosome was full of genes arranged linearly like beads on a string. Just as the chromosome had a fixed shape and structure so did these genes have fixed places, never shifting about loosely. Each gene was primarily effective in the production of some character in the body. In the case of many mutations in one gene, as in the white-red eye series mentioned before, the gene for red eyes simply underwent many kinds of changes resulting in different forms of the same gene.

It was soon realized that a gene is not a magic bundle that produced a character in a miraculous fashion. The gene for vestigial wings will produce those very short wings only at 25° C.

At higher temperatures the wings are longer and at 30° C they are almost the length of normal. Hence a gene will produce a given effect only under given circumstances in the external environment. There are many more instances, but the one given will suffice. Moreover, the gene for vestigial affects other organs in the body, but to a much smaller degree.

There are many characters which can be traced directly to the work of several genes. They are called cases of multiple factors. In mice, for instance, the gray coat color will be had by animals only if they carry the dominant gene for color *C* (*cc* is albino) and also the dominant gene *A* (*CCaa* is black and *ccaa* albino). The animal must be *CCAA* or *CcAa* to be gray. The character gray, therefore, depends on the presence of two genes. There are characters reported which depend on three or more pairs of genes.

It was also found subsequently that a mutant gene may appear which, for example, when present in a vestigial fly will affect it so as to undo the work of the vestigial gene. Such genes are called *modifiers*. They modify, affect or change the action of another gene and can only be detected through that effect. The specific gene referred to here is called *vestigial modifier*. A fly carrying the vestigial modifier, but not vestigial, will not be noticed ever to be different from a normal fly. Only the presence of the vestigial gene brings out its essential genetic function.

These last brief statements should make it clear that the gene must not be taken as a mystic mechanism, the presence of which on a chromosome means the inevitable production of the specific character. Such mechanical thinking is inaccurate and sterile. We must realize that laws and generalizations are made on the basis of certain experiences which are never isolated, but on the contrary, organically and functionally linked with the environment of which they are an integral part. If those states or components of the environment are not included in the generalization, they are invariably assumed. They must be stated clearly, however, if their omission leads to error.

In relation to the concept of the gene several instances have shown that even among scientists there are some who will rush headlong for confusion whenever the effort to hold them back slackens. Thus, many so-called geneticists have failed to see that a gene will produce its effect only in given external and internal environments, meaning by "internal" the set of genes among which the given gene finds itself. It is impossible to separate the action of a given gene from the environment in which it acts, and it is false to speak of heredity vs. environment because there is no such opposition. The correct notion is that the two are inseparably linked with one another and are integrally dependent upon each other. Theoretically, the action of every gene can be modified by proper changes in other genes or in chromosomes or by changes in the external environment such as temperature, moisture, food, vitamins, hormones, etc., etc.

The process of mutation occurs in all genes, though with differing frequencies. Some genes mutate once in 50,000 individuals, some only once in 300,000 and so forth. The mutant races which have arisen so far in *Drosophila* include virtually every character that could be examined. There are up to now approximately 570 mutations affecting eyes, their shape and color, wings, size, shape and venation, bristles, body color, size of animal, shape of abdomen, balancers, antennæ, aristæ, etc. Mutant types have been found which show different instinctive behavior and reflexes. As a rule, fruit-flies invariably climb upwards, away from the center of the earth. A mutation has been found which fails to do that.

By far the largest majority of mutations are *lethals,* which means that they kill the fly. Such factors can be studied by being linked to a visible character. When that character is missing, we know that a lethal mutation has arisen on the same chromosome with it. Lethals vary as well. Some kill in the early stages of the development of the embyro, some in the larval stages, others in the cocoon or later.

It is easy to see why the majority of mutations are lethal. The living organism is a finely balanced mechanism in a state of delicate equilibrium. Such well adjusted equilibrium is obtained after long processes of evolution and selection. In the same sense as a child's playing with a watch is more likely to spoil than to improve it or leave it unharmed, so does the disturbance affected by a mutation stand a higher chance of upsetting the equilibrium needed for life than of modifying it in a neutral manner. Consequently, about 90 per cent of all mutations are lethal and only 10 per cent or less survive and produce visible changes.

All mutations mentioned so far referred to genic mutations, that is, to changes in genes. There are also chromosomal mutations, that is, changes in the structure or number of chromosomes. Occasionally a chromosome breaks in two, and that change, once having occurred, becomes perpetuated. Sometimes a small piece breaks off one chromosome and becomes attached to another, etc. Occasionally the entire chromosome number gets doubled so that instead of having ten pairs, the organism now has twenty. It should be added here that duplication of the entire chromosome set does not seem to kill the organism, but an extra chromosome or lack of one, or for that matter an extra piece or lack of it, will sufficiently upset the balance to kill the organism.

When we talk of mutation, it should be assumed that we mean genic as well as chromosomal changes.

Until a few years ago we were entirely ignorant of the possible causes of mutation. We only knew that mutations took place with a given frequency as established by observation and statistical treatment. In 1927, however, H. J. Muller, a student of Morgan, published the results of his experiments in which he definitely established the fact that X-rays had the power of producing both genic and chromosomal mutations in the fruit-fly. This brilliant observation opened a vast field for study. Muller's epoch-making discovery was soon applied to other animals and plants and was found to be generally true. Moreover, the number of mutations obtained is directly proportional to the strength of the X-rays applied. The stronger the X-ray energy, the larger the number of mutants obtained. Radium emanations are also effective.

In treating an animal or plant with X-rays to get mutations, it is impossible to make a prediction as to the appearance of any given type. For instance, with a given strength of X-rays, we may predict that 2 per cent of the offspring will be new mutants, but we cannot predict that one of the new types will be curly wings. The X-rays seem to attack the gene and modify it, but we have no way of foreseeing which genes they will hit in a given experiment and how they will change them. There is the same randomness in X-ray induced mutations as in naturally occurring ones. It should be added that the high frequency of lethal mutations was based on experiments with X-rays. Naturally occurring lethals cannot be as well studied.

Mutations affect every character in the body and occur in every plant and animal all over the earth at all periods of life on earth. They are a universal phenomenon completely beyond our control except for experimentation with X-rays.

CHAPTER V.

Evolution and Its Present Status

The first students of natural science in the days of Aristotle, and particularly in the sixteenth and seventeenth centuries, when the firm foundations of the scientific method were being laid, were struck by the tremendous variations in animal and plant types in nature. For a long time the seemingly boundless multiplicity of forms was so vast and bewildering as to defy orderly classification, without which no beginning could be made in the study of relationships.

Linnæus was the first to suggest a convenient and efficient system of classification and designation. His system is fundamentally still in existence and consists of the dual scheme of names, one of the larger group, the genus, and the other the smaller group, the species. Man, for example, was termed *Homo,* for the broad genus of man-like types now extinct, and *sapiens,* meaning wise, for the type existing today. In this manner every plant and animal could be conveniently catalogued.

Linnæus, however, still believed in the biblical theory of special creation which implied that every species, designated as such in his scheme of classification, was created by God. This meant, in addition, that the species was immutable and had retained and would retain its characteristics as of the day of creation. This concept of special creation assumed then, that no change whatever had taken place in the biological world since those memorable three days, third, fifth and sixth, when God created all plants, all animals of the sea and dust and all beast, cattle and man respectively.

This static and idyllic picture of nature could maintain itself only so long as there was ignorance concerning the real facts of biological life. Not that Linnæus was ignorant. On the contrary, he was one of the most informed and most brilliant men of his time. But the study of biology was still in its infancy in his day and little knowledge had been accumulated concerning the origin of new types, their mode of inheritance, their rate of becoming established, etc. That did not take definite shape until a century after the death of Linnæus, although even during his life the ground was being laid for the coming changes and the concept of evolution began breaking through in the philosophical writings of such men as Buffon, Cuvier and particularly Lamarck.

As is often the case in the development of ideas, Lamarck, who came out openly against the notion of special creation, went to the other extreme in claiming that nature continuously created new forms out of inanimate matter under the influence of light, heat and electricity. His chief contributions of value were his conclusion that all classification was arbitrary and that plants and animals evolved from each other in a gradual and continuous manner. The idea of evolution had been upheld by Buffon and Cuvier as well, but these biologists believed in several creations of different types after respective catastrophies. In this manner they tried to harmonize the obvious phenomena of the appearances of new forms in time with the biblical concept of creation.

Lamarck also stressed evolution of organs in the body. He saw that primarily evolution occurred through changes in the specific organs of animals. Animals that did not have any wings, eyes, horns, tails, etc., developed them, and those that had them in primitive forms improved them through modification acquired in time. To account for the way in which these organs came about Lamarck postulated what became known as the *Use and Disuse theory*.

This theory is a naive attempt to state the cause of biological modification by postulating that when an animal uses a certain organ, that organ will develop in a way to improve its particular function, and that such structural and functional improvement once achieved becomes inherited. Conversely, the disuse of a certain organ causes its gradual degeneration. These modifications become inherited and a generation is finally obtained in which the disused organ is nonexistent or merely a vestige. In this manner this theory tries to explain the evolution of new forms from the old, the creation of new types, organs and characters and the disappearance of others. There are many people today even, who are unaware of the facts of genetics and are firm believers in this theory. There is no doubt about the fact that organs of animals become modified by use or disuse, but we shall see later that such modifications do not become hereditary. It should also be pointed out that Lamarck postulated vague and idealistic "tendencies to progression" and assumed teleological or purposive forces guiding the course of evolution.

It was left to Charles Darwin to put the theory of evolution on a sounder basis and to point out at least all the difficulties involved. He realized that species was a concept created by man and defined by him in an arbitrary manner and that it was not a definite, absolute phenomenon in nature. This realization was directly connected with his observation that species could not be defined in a strict sense and that whichever way one defined it there were many reservations necessary. Any two closely related, that is, similar species had many intermediate types which formed a gradual but continuous chain of modifications merging one species with the other.

Everywhere Darwin turned he saw this continuity of types with small modifications or variations. He found such continuous variations in animals as well as in plants, in the wild as well as under domestication. He saw that species were not absolute, separated by definite ironbound limits but, on the contrary, were merging continuously. Occasionally there were gaps where the continuity seemed broken and where no evidence was available to show any connection between those widely separated types. But evidence came from many other sources.

Geology had just then gained the status of a science through the work of Lyell who brought out clearly the idea of continuous transformation of the earth's surface, the formation of rock layers and their erosion by various environmental agencies. The magnitude of geologic time also became approximately known. Obviously, it was inevitable that such information exert a strong influence on the mode of biologic thought.

Paleontology too brought forward results of the study of imprints that living forms left in petrified forms. Both plants and animals either were petrified whole and remained buried in rock or left their outline on sand which in the course of time turned into stone. Such remnants converted the layers of rock into a magic book full of tales of the past, documented with factual illustrations. From such evidence it became apparent that in many cases where there was no apparent continuity between species, types had existed in the past which showed precisely such characters. Those types were no longer in existence because apparently they had perished.

The existence of external similarities between types and species were made more meaningful by a study of their comparative anatomy and embryology. These two fields of study revealed that not only animals or plants which were superficially alike but even those that differed externally, seemed to be biologically closely related. Through a study of embryological development it was found that widely differing organs such as the wing of a bird and the foreleg of a horse developed essentially from an identically constructed prototype upon which different modifications had been superimposed. Those modifications, entering late in development, so changed the essentially identical structure or course of development of the two types as to give them entirely different appearances. Obviously, relationships cannot be based exclusively on final appearances but the developmental course has to be considered as well as a significant part of the biologic characteristics of a given organism.

The study of the geographic distribution of types proved to be very instructive in elucidating the general question of biologic relationships between similar and dissimilar organisms. Darwin had the opportunity of travelling widely and studying both sea and land forms practically all over the world. He found that islands lying near a continent, as for example the Galapagos Islands west of South America, invariably were populated by animals and plants that were strikingly similar to the types on the continent yet varied superficially from them. Whenever such a relationship was observed from biologic studies it was always found that the islands in question had, geologically speaking, only recently been separated from the mainland. It was reasonable to suppose that the erstwhile continuous body of land had been populated uniformly by the same species which subsequent to separation began to develop different variations on either side of the barrier, in this case, the straits.

It was found on the other hand that Madagascar, though situated so close to the African continent, had a fauna (animals) and flora (plants) that differed widely from the African but had more in common with the types of India. Geologically the evidence seems to point in the same direction. The biological evidence also agrees with the conclusion of geologists that the separation of Madagascar from the mainland occurred in the far distant past. The biologic evidence consists of the fact that the organic life of Madagascar differs far more fundamentally from that of its parent mainland than the life of the Galapagos differs from the South American types.

All of these considerations and analyses led Darwin to postulate the theory of evolution, that is, of the origin of new types by descent with modification from previously existing types. Essentially Darwin dealt more with the origin of species and not so much with types in a loose sense. Darwin's theory of evolution was not based on vague speculation, but like all great scientific theories was a bold and brilliant attempt to postulate a mechanism which would unify and coordinate all of the previously mentioned fields of biologic study. At the same time it also tried to replace the bankrupt theory of special creation and its corollary of the immutability of species, and give an intelligent, scientific answer to the question of the origin of all species.

Employing in a general sense the scientific mode of thought, Darwin was not merely satisfied with elaborating a philosophic theory and leaving it at that. He labored constantly to accumulate more data and to test as far as possible every hypothesis, every suggestion and every objection. His approach was experimental and operational and not abstract and theoretical. It is to be expected that his method be limited by some ideas and by the general information available at the time.

Darwin tried to construct a clear picture of the mechanism and causes of evolution. The first question to be answered was—how do new species arise? His answer to the question was—by means of accumulating numerous modifications or variations that arise in the course of time. Darwin realized that not all variations survived, and what is more, that not all established species survived. He was therefore confronted with the question—what is this force in nature that permits some variations and species to live and causes others to die out?

The answer to this question, according to Darwin, was natural selection. Darwin suggested that all animals and plants had to "struggle for existence" when confronted with the forces of nature. He suggested further that animals and plants that were similar in makeup and inhabited the same region were involved in a competitive "struggle for survival." The sum total of these struggles and their consequences, resulting either in the biologic survival, meaning perpetuation, or in the extinction of a given species, Darwin named natural selection.

Accordingly, natural selection was considered by Darwin as the sole force operating for the establishment of new species. "New species in the course of time are formed through natural selection, others will become rarer and rarer, and finally extinct. The forms which stand in closest competition with those undergoing modification and improvement will naturally suffer most." (Origin of the Species, Chapter IV.) Natural selection formed new species by bringing about accumulation of favorable variations as they arose, until a new species resulted. Unfavorable variations were eliminated, as were also established species meeting with competition from the better equipped, related types.

Darwin was confused in his answer to the question where variations came from. Although he in places denied the validity of the use and disuse theory he defended it on other occasions, saying that it was hard to see how variations could have arisen in any other way. At different times he suggested that it was the general conditions of life of a given type that produced variations. He spoke usually of all variations as favorable. On other occasions he stated that natural selection was responsible for the variations, saying that "natural selection . . . can modify the egg, seed, or young, as easily as the adult." He also spoke of the "incessant struggle of all species to increase in numbers" and stated that "natural selection . . . leads to divergence of character and to much extinction of the less improved and intermediate forms of life."

Darwin was not aware of the laws of genetics though he was fully cognizant of the significance of heredity. He even experimented with some hereditary characters in pigeons and dogs, but after many laborious efforts gave up in despair, saying that the results bewildered him and defied analysis.

In evaluating Darwin's work it is necessary to point out that his clear presentation of the continuity of all living forms, the arbitrary nature of the concept of species, the theory of evolution accompanied by vast painstaking labors in all fields that supplied evidence for that theory, and the concept of natural selection in its broadest outline, form genuine contributions in the field of biologic thought. Aside from the brilliance of the theory it happens to occupy a unique, monumental place in the history of thought because of its tremendous implications in all possible fields.

It should, however, be clear that Darwin, like most other men of genius, was limited by his time. In spite of his boldness and originality in some directions he retained many notions that proved later to be unscientific and anthropomorphic. In many of his postulations he was unclear, even confused, while others were proved by modern genetics to be entirely false. Such a concept as "the struggle for existence" even though it is used so frequently and so authoritatively by many people, is a vague term more romantic and muddled than scientific and operational. Of the same nature are other quotations given above. In all fairness to Darwin, let it be stated here that the most confused of all phrases, namely, "the survival of the fittest," was coined not by him but by Herbert Spencer, an adept at such tasks, in spite of his reputation in the last century as a great thinker.

It is obvious that in the absence of knowledge of genes and mutations Darwin was bound to be wrong in any attempt at explaining the cause of variations and the nature of such. Instead of discussing his errors or limitations of knowledge let us present the mechanism of evolution as constructed on the basis of all information available to date.

Genetic research indicates that the basic cause of all change, of all biologic variation in nature, is the process of mutation. Mutation is a continuous process occurring with different frequencies in all genes with few, if any, exceptions. The force of mutation knows no objective, purpose or value. Mutations occur at random affecting any possible character, habit, structure, instinct, capacity, etc., of the organism. There is no guiding force deciding that one organ or another should be more or less modified, as the case may be. On the contrary, mutation is blind, undirected and strictly random. It is not the living conditions in a given environment or the desirability of change that produce mutations, nor is it the "tendency towards progress" or the use or disuse of a given organ. It is nothing else but an observed fact that every so often a gene, which for many generations reproduces its kind, will suddenly give rise to a different gene, producing different effects. It is also a fact that practically every gene in the body can so change, and that the modified characters may or may not be harmful to the organism.

Beginning then with the basic and inescapable tendency of genes to mutate, let us follow the series of subsequent events and trace the devious path that leads first to the formation of new characters and later to the formation of new types.

A mutation is presumably some kind of physical change in the material particle on the chromosome, known as the gene. This change is invariably so involved in the psychologic-developmental reactions in which genes participate, as to produce a different end result from the pre-mutation gene. This different end result is the visible character.

Not always, however, are the changed processes which are produced by the mutated gene harmonious with development. On the contrary, evidence from X-ray treatment seems to indicate that the vast majority of mutations are lethals, that is, they upset the relationships needed for life. We see then, that after a mutation has occurred, two possibilities present themselves. First, the mutated gene may be lethal, in which case it is non-existent as a character and of no interest to us from an evolutionary point of view. Second, the mutated gene is not lethal, in which case it produces a new character either as a dominant or recessive. The same, of course, holds true for chromosomal as for genic mutations.

While the lethals are of no concern to us, the viable mutations are, since it is they who form the characters out of which different types originate. We may speak of the events in which some genes prove themselves to be lethals and others viable, as the *embryonic selection.* The term refers to the sum total of circumstances which determine whether a given mutation expresses itself as a character or does not, and consequently perishes.

After a new gene has managed to emerge victorious, to use a dramatic simile, from the test of embryonic selection, its troubles only begin insofar as the character it produced is confronted with the forces of the arena in which the organism as modified now has to maintain its existence. If the character is such as *to be compatible with the continuation of the life of the organism,* that organism will survive. If, on the other hand, the new character functions in such a way as to be incompatible with the continuation of the life of the organism, that organism will perish. This process has been called by Darwin—*natural selection.*

It is to be remembered that the phrase *natural selection* means nothing more than that, and any more specific statement of it is bound to be misleading. Plainly speaking, natural selection means that animals (or plants) which cannot live—die, and those which can live—survive. When a certain character persists, survives in a given environmental setup, we say that that character was favorably selected. When a given character is in the process of numerical multiplication and expansion we say that it is being selected *for,* and when it is in the process of numerical diminution we say that it is being selected *against.*

By way of summary we see then, that embryonic selection works as a sieve, as a censor for mutated genes determining, figuratively speaking, which should be expressed as characters, and which should not. Having come into existence through this severe test, the character then faces the forces of the environment, and the result of the interaction between the two is called natural selection. Those characters which are compatible with life in a given environment survive, the incompatible ones perish.

Unfortunately, a great deal of loose talk has shrouded the theory of evolution ever since its inception. Such terms as "survival of the fittest," "nature selects the best," "the animal tries to adapt itself," etc., only lead to confusion. If the meaning of the preceding paragraphs is fully understood, that will be apparent. It is unenlightening to talk of an animal being fit or unfit for a given environment, just as it is pointless to talk of the environment as being fit. An animal needs certain conditions and properties for survival. When these are fulfilled it survives. When they are not, the animal may die.

We must bear in mind the difference between natural selection which is undirected, except by the general laws of nature, and artificial selection by man, which is planned and guided. When man selects, let us say, chickens for their good egg laying characteristics, he knows exactly what he wants and has learned from past experience how best to achieve it. He has a purpose in his selection and acts in an intelligent way. Nature knows no such animus or purpose. Its selection is entirely controlled by the laws of nature, organic and inorganic. Ascribing a purpose or intelligence to it is totally childish and anthropomorphic. Yet that has been the cause of all confusion in connection with evolution.

It should be pointed out that the mechanism of selection is extremely little known. Many books have been written about it but few experiments have been conducted and practically no analyses made. We often hear people say with perfect equanimity that wingless flies stand no chance of surviving in nature because they cannot fly. Yet there are millions of types that do not fly but crawl and somehow manage to survive quite nicely. Indeed there are thousands of seemingly clumsy and ill adapted animals that survive millions of generations and show no tendency to become extinct.

Many writers on biologic thought adapt a deplorable mode of rationalization of all evolutionary data. When a certain animal is found to have died out at a given geologic period, they offer any kind of theory, to "settle" the problem more than to really find the cause. Their mode of settling is usually speculative and anthropomorphic, of no scientific value and most often harmful. Practically all talk about protective colorations, striving to perfection, mimicry and sexual selection, belongs to that category, and should be viewed with suspicion.

Since selection is the product of the interaction between the animal and its environment it is obvious that in order to understand the mechanism of selection we must learn the various components. These are the animal, its interaction with components of the environments singly and together, and the limits of variations of that relationship. Only by studying the physiology, genetics and behavior of the animal and its biologic responses to various combinations of environmental forces, as well as possible changes in those forces, can we hope to know exactly what the reasons may be that produce extinction or spread of a given species. In the absence of such knowledge it is best to limit ourselves to general but clear and concrete statements of fact.

In conclusion, it is desirable to say a few words about the present status of the problem of *inheritance of acquired characters*. The phrase implies that in the course of interacting with the environment some specific organs of an animal become modified and that such modifications are inherited. We may take the commonly used example of the giraffe which presumably kept on craning its neck to reach leaves on tall trees until its neck lengthened. These gradual lengthenings, the saying goes, became inherited and produced the giraffe of today.

The above illustration, it should be noted, was only meant to be a speculation, even though it has been repeated by many so-called biologists as a sound theory. Actually, numerous experiments have been conducted to test the hypothesis, and their evidence has been so strongly and conclusively against the theory that the whole problem has lost the great significance attributed to it in the past.

Some characters are not affected noticeably by the environment. Colored animals and men have been reared under different environmental conditions for many generations and have not been significantly changed. The superficial modifications that did appear were certainly not inherited. The same holds true for eye color and many other characteristics. Some properties, however, are known to be affected, namely, height to some degree, general health, etc. Yet it is known that these changes are not inherited. Over one hundred generations of flies have been bred in the dark but the hundred first generation behaved normally to light when put to the test. The flies neither became blind nor did their offspring. Similar experiments have been conducted with many other properties.

Weismann, who was the first to question the truth of Lamarck's notion of inheritance of acquired characters, cut off tails of many generations of cats and found no change in the offspring.

It is known that Jews and Arabs have circumcized their male offspring for many hundreds of generations and still have to do so since the presumed inheritance of acquired characters has failed to do it for them.

Many people employ the fallacious argument that a chicken does not fly because it had become domisticated, did not need the use of its wings, hence lost the capacity for flying, and transmitted that loss to its offspring. This statement happens to be precisely the reverse of the real situation. Actually, it is more in accordance with the facts to say that a chicken does not fly because it lost by mutation the capacity for flying and that the ensuing conditions made it possible material for domestication. There is an important distinction in these two statements which must be clearly understood. The first presupposes the inheritance of acquired characters, the second states the case as it really happened.

It is common knowledge that an athlete develops his muscles and that practice improves and modifies any given organ. There is no quarrel with this statement except that the effects of practice are limited by capacity, as we shall see subsequently. The discussion here only refers to the fact that such modifications are not inherited.

It is easy to see how the concepts of genes and mutation expose the foolishness of taking this problem at all seriously. Every hereditary character must be due to a gene, and every modification must have arisen by a mutation. Hence the defenders of the theory of inheritance of acquired characters, if they wish to be consistent, must claim that the modified character produced a mutation within the gene responsible for that character. Clearly this is not so, since we know that modifying an organ does not produce mutations. Our present knowledge of genetics thus closes in a final manner a much discussed problem of the past.

CHAPTER VI.

Evolutionary Formation of Race, Stock and Variety

The term "race" has always been used so loosely that it is little wonder no definition of it is available. Unlike *species,* it was not introduced into our language by biologists but by politicians and journalists. Biologists know what species means, it has been defined arbitrarily for mutual understanding, and they know even who suggested that term. The word "race" is supposed to be a biological concept yet no biologist ever coined or defined it, and the name of the founder of that concept will forever be an impenetrable secret.

Consider its use in popular language. We say the human race, the white race, the Caucasian race, the Nordic race, the German race and even the Bavarian race. Hence we use it for six successively smaller groups. Of what value is a word, presumably designating a biologic group, presumably a scientific term, when it can be used so broadly?

In a subsequent chapter we shall discuss the social uses to which the term "race" has been put and the political implications of the concept. At this point we want to bring out the biologic meaning of the term, as well as the biologic explanation of the wide variation within a species. We have already discussed variation in the biologic world as a whole with species as the basic unit. Now we must turn our attention to the group classified as species and examine the variations within it, study methods of classifying them, and analyze the meaning of each variation.

It was stated at the beginning of Chapter V that the baffling diversity of forms in the plant and animal worlds was satisfactorily organized by the introduction of the concept of species. That is perfectly correct on a large scale. One does not, however, need to be a particularly acute observer to see that within every species there is very wide variation as well, even though it is on a smaller scale and naturally within narrow limits.

Let us consider the species of the dog, *Canis familiaris,* or man, *Homo sapiens.* Within each we find large subdivisions such as the terrier, the bull dog, the dachshund, St. Bernard, etc., and Indian, Mongolian, Negro and white, etc., in man. These large subdivisions have many features in common, but within the limits of each subdivision we find further variation, and within that group still further until we come down to the lowest rung in the ladder—the individual. On comparing individuals we find that no two members are identical, even if originating from the same family.

We see then, that a species by itself presents a world of variation and that some orderly scheme of classification is essential for convenience of study and general systematization. The problem of classifying groups within a species is just as important as the problem of classification down to species, solved by Linnæus.

Until now no such scheme was forthcoming because of the necessarily arbitrary nature of such classification and the absence of any guide. Genetics, however, supplies us with a method and a scale for convenient classification within a species, because that is exactly the sphere of genetic research.

A species is defined as a group of plants or animals, of similar structures and properties, that produce fertile offspring with one another, and either cannot mate or are sterile, or produce sterile offspring with members of another group. Clearly this is an arbitrary definition. Recent experiments have shown that sterility may be due to a gene in the same sense as any other character. Hence it is possible to mate two individuals, members of the same species, each carrying the gene for sterility in heterozygous form, so that some of their offspring will be sterile. It is also possible to make crosses producing all sterile males or females. On the other hand, chromosomal mutations have been found which were fertile *inter se* but sterile with types of other chromosomal arrangements.

Recently a botanist in the Soviet Union has succeeded in producing a hybrid between a cabbage and radish. This hybrid is fertile *inter se* and reproduces only its kind, but is sterile with either of the parental types. According to the accepted definition of a species, this botanist was the first to create a new species even as did the biblical god in those busy days of creation.

Genetics deals with the transmission of hereditary characters. Obviously its chief concern is with crosses within a species, since members of different species are presumably sterile with one another, even though there are many exceptions to it. Hence genetics is in a position to establish biological relationships among members of the same species, and it alone can offer some means of grouping the different types within a species. It does it in the following manner.

Early in the work with *Drosophila* many mutant types appeared, as was pointed out in Chapter II. They were isolated and bred, and homozygous lines were established. A name was obviously needed for such types and the name given to it was *mutant race*. It so happened that either by accident or design the word "race" was used here for the first time by biologists, and in such a manner as to give it real and significant scientific meaning. The word "race" was used to designate a mutant type, distinguished by a modified character.

This use of the word "race" for any mutant character has real significance if we consider the meaning of gene and character and their relationship. It was pointed out that the process of evolution involves, first, mutation, second, embryonic selection and finally, natural selection. Obviously the forces involved in mutation and embryonic selection are largely of a different nature from those that constitute natural selection.

Natural selection determines, figuratively speaking, which characters should and which should not survive. It does not react with the gene, the cause, but with the character, the end result. While *gene* is the term for the unit hereditary factor, for the unit cause of the physiological development of characters, the character itself is the unit of evolution. Those characters which are compatible with life under given environmental conditions survive. They are involved, therefore, in the process of accumulation of variations to form the multitude of types and species existing today. They are the raw material of evolution.

The term *race* applies, then, to a single character change produced by one or multiple genes. It is the unit of evolution, the building stone of the evolutionary edifice just as a cell is the unit of the living organism.

Character is a term of observation. By observing two species or types we notice the characters involved and note their differences. Real fundamental differences between individuals and real biologic descriptions of them can only be achieved by expressing each individual in terms of genes and chromosomes. We have seen before that judging identity by similarity in character is very misleading. Thus, black and ebony are both darkly pigmented yet due to different genes.

Hence, real descriptions and comparisons of species and individuals can only be done in terms of genes and chromosomes and not, as is being done today, in terms of characters, in terms of description of external appearances. We do that because we cannot help it since the genetic basis has not yet been worked out for more than just a few animals and plants.

A beginning has already been made by way of expressing relationship between species in terms of genes, not appearances. In the fruit-fly *Drosophila* there are two species, *melanogaster* and *simulans*. They cross with difficulty and the hybrids are sterile. The two species are very much alike in appearance and in the course of breeding have produced similar mutations, the genes for which were located on their respective chromosomes in each case, so that chromosome maps were available for each species. By mating *simulans* to *melanogaster* individuals of similar characters, say, black *melanogaster* to black *simulans,* white eye *melanogaster* to white eye *simulans,* etc., it was found that in the hybrid the same effect was produced. Hence the genes are identical. By comparing mapped chromosomes it was found that most of the genes lay in the same order in the two species but that here and there a chromosome piece with its genes would be missing in one species, another piece inverted or translocated. Also, some genes were different in the two types. Hence, species differences are due to genic and chromosomal differences. In related species most of the genes and even their order on the chromosome are the same. Their real relationship can only be expressed in terms of genes and chromosomal structures which they share in common and those in which they differ. Under present conditions, however, we can only classify related types by means of characters.

In *Drosophila* we have mutant races that affect every character of the organism. They are the white eyed race, black body, vestigial wings, bobbed bristles, cut wings, echinus eye, bar eye, lobe eye, curly wings, aristaless, speck, dichæte, spread wings, yellow body color, twisted abdomen, etc., etc. These are all classified as races, due chiefly to one gene. However, in mice, gray color is a unit character, yet due to several genes. It should be noted that introducing a hierarchy here and deciding that one mutant race is generally superior to another is nonsense. We cannot say, biologically speaking, that cut wings is an inferior or superior character to black body or short bristles. We may compare them on the basis of their survival, that is, selection, but not vaguely or morally.

Man is an animal for which the same laws of genetics and classification apply as those found applicable to other animals. We realize the truth of this statement when we do not permit politics and economic interests to confuse and pervert our scientific integrity. In the case of race we must use the same term in man to designate characters as we use in *Drosophila*, mice, etc. Thus, we have races characterized by blue eye, or dark hair, various skin colors, color blindness, hæmophilia, short fingered condition, etc., etc. As in the case of all other animals and plants each character constitutes a genetic race.

Brown eyed and blue eyed individuals differ from each other in a character just as a white skinned individual differs from a dark skinned in a single character. They cannot be compared on any other but survival basis. If they all survive alike no scientific hierarchy between them can be introduced and all superiority and inferiority notions are meaningless from a biologist's point of view.

From the concept of race outlined some interesting points follow. It is obvious that descent from a common ancestor does not make individuals belong to the same race. We have seen that it is possible to breed two gray bodied individuals and obtain one-quarter of their offspring black bodied individuals. These will belong to the black race while their gray brothers and sisters will be placed in the gray race. The same holds true for any other character. Thus blue eyed humans belong to the blue eyed race while their brothers and sisters may belong to the brown eyed.

Conversely members of the same race may produce offspring of a different one, as seen from the same illustration. Hence race affiliation, so to speak, must only go by character, by inspection and not by descent or relationship.

However, it is a fact that individuals of a given species differ in many characters. Since race refers only to unit character it is clear that further classification is necessary. A solution to that problem suggests itself readily.

In *Drosophila* it was found desirable for breeding purposes to have flies that had many mutant characters in one individual. Such types cannot be called mutant races since they differ from wild type in many characters. They are called *stocks*. Again, because this term has real meaning, it is suggested that it be used to designate a biologic group on a higher level than race, namely, a group that differs from other groups in many characters.

Let us go one step further to complete the entire scheme of classification within a species and then consider its mechanism and meaning. Stocks differ in several characters. However, many stocks may still be further correlated by having much more in common with each other than with other sets. Stocks can therefore be grouped into varieties, the largest subdivision possible within a species.

To take a concrete illustration in man. The human species, *Homo sapiens,* can be divided into several varieties such as the white, Negro, Mongolian East Indian, American Indian, etc. It is not at all on the basis of color that this division is made, but on the basis of the large number of characters in which these groups differ such as hair, eye color, skin color, nose and face structure, etc. Within each of these varieties there are further subdivisions into stocks such as the Abyssinian, Zulu and Nigerian Negroes, or the different Mongolian, white or Indian types. Stocks differ less widely from each other than varieties, or, more strictly speaking, have much in common with each other by virtue of belonging to the same variety. Stocks are then divided into their component characters, into races. Further subdivisions of stock into any other subordinate groups but races would be clumsy and not at all advantageous.

If we analyze the origin of variation we shall better understand the meaning of the classification of a species into varieties, stocks and races, as described.

A type possessing numerous common characteristics arises only through *random mating.* This term means that blue eyed individuals do not mate only with blue eyed, bald with bald, hæmophilic with hæmophilic, etc., but, on the contrary, mating is independent of identity of characters, which means it is random. It is clear that through random mating, any mutant gene, let us say a recessive, will spread through the population and will not be noticed until two individuals heterozygous for it will accidentally come together and mate. One-quarter of their offspring will then show the new character, if it is a visible and not a lethal.

The character will now go on spreading further in the population, again through random mating. The only limits to the spread of a character are *geographical.* This means that a character, arising in a population of dogs or cattle on an *isolated* island can only spread throughout this island and no further. This is the meaning of isolation. Surely animals cannot mate platonically at a distance through spiritual or immaculate communion, beyond the geographic borders.

Geographic isolation and random mating are the chief factors responsible for the formation of types from material supplied by mutation, embryonic and natural selection. Within a given isolated geographical area, mutations accumulate and spread through the population. Random mating can be compared with molecular movement which causes in time equal distribution of all types of molecules within a mixture of gases. In the case of a gas, the limits within which equal distribution takes place are the walls of the vessel containing the gas. In our case, the limits are geographic barriers.

It is precisely for this reason that different continents which are defined on the basis of geographic barriers, are populated by different varieties. In Asia, the Himalayan mountains form a solid barrier and therefore separate the Mongolian from the Indian variety. When within a continent there are effective geographic barriers, they will have a biological effect. In Europe, on the other hand, isolation is out of the question. The fate of the Finns and Magyars is proof of that. They were both Mongolian stocks a few hundred years ago but have almost lost all of their characters by inbreeding with whites.

It will be easily understood why the continent of Africa was populated entirely by the Negro variety. It was not the sun or the climate that produced the Negro variety but the accumulation of mutations that distributed themselves by random mating throughout the population and were stopped from further biologic spread only through some insurmountable geographic barriers. This happened a very long time ago. In the course of time, however, the original Negro variety became itself modified.

It seems reasonable to assume that the original Negro type occupied not the entire continent but a small part of it, and subsequently spread through migration. The groups that migrated at different periods occupied different regions, developed different languages, different customs, traditions and cultures, and began to form tribal or national entities. This social superstructure together with some minor geographic barriers, although these were not always required, became forces operating for group unity and cohesion. Consequently, mutations that arose within such a group spread within it and gave the group new and common biological characteristics. In this manner, groups that have sprung from a common ancestral community became biologically differentiated. The reader should recall here that mutations occur at random and that seldom do the same mutations appear at the same time even in closely related groups. Hence the formation of differentiated groups within a variety.

It is important to realize that in a communal animal such as man the social and cultural structures of a tribe or group become strong forces for isolation. Migration and intermingling, obviously tend to break down such segregation. But they are only sporadic. As a rule, social and partly geographic isolation account for the origin of different stocks of a given variety. Such different stocks arose all over Africa. The Abyssinian Negro belongs to one stock, the Zulu to another, and the Nigerian to a third, etc.

The same reasoning applies to the other varieties of man, found in different continents.

Clearly, within a stock there is still further differentiation. Not all members of the Abyssinian stock, of Korean or Persian, etc., are alike. These differences are due only to mutant races that are still in the process of flux, of either spreading further through the given stock or are in the course of being extinguished. Hence the smaller subdivision next to stock can only be race, as defined above.

Being in the course of flux, of either spread or extinction, race cannot be a very useful term of classification in man. It has clear biologic meaning and is the unit of evolution, but has no social meaning, since any individual may belong to any race according to the character by which we choose to classify a population. Randomness of mating is very strong because of our large population and the ease of communication and spread. For this reason the *biological scale* is not *socially* useful.

Fortunately, another unit has recently been suggested, a social unit, namely, nationality. Man is a social animal and develops mighty traditional and cultural structures because of it, and therefore needs a social standard of measurement, a social unit. Nationality has been defined as a group of people occupying a contiguous geographic area, having a common economic life, common history, culture, language, tradition, hence a common psychological heritage (of a social kind). We all know, that national affiliation is independent of biology, as indeed is apparent from the above definitions.

Let us see how this concept and definition aid us in achieving clarity where biology could be of no help. Let us take the case of the American Negroes. Obviously they are descendants of the

Negro variety. Yet the Negro slaves that were brought here came from all parts of Africa, were of all kinds of stocks. Here they mixed at random very rapidly until all stock characteristics were eradicated. They cannot be biologically conveniently classified, not even as a stock to be compared with some stocks of African Negroes. This is so because of the vast intermating between whites and Negroes in the United States resulting from wholesale raping of Negro women by their white masters during and after chattel slavery. Out of twelve million Negroes in the United States ten million are mulattoes! Consequently the Negro population of America does not even retain the characteristics of the Negro variety but is constantly losing those in contact with whites. Hence they cannot be considered even a stock of the Negro variety but what they are in fact, namely, mixed Negro and white individuals chiefly, plus a mixture of various Negro stocks.

A social classification, however, is possible and helpful. Socially they must be classified as a nationality since they fulfill the definition given above. They do occupy a contiguous area in the South where they form a majority of the population (whether the area is narrorw or wide in places is of no consequence), they have a common economic life, culture, language, tradition and psychology because of their common social position of being oppressed. Hence their social character as a group can be scientifically well expressed and their biologic origin and composition clearly understood, without confusion, and genetically studied.

The whites of Europe and the Americas are in a similar biologic condition as the Negroes of North America. Within the white variety, stocks have been almost completely annihilated by migration and intermingling. As was pointed out before, stocks only retain their identity and value as subdivisions by virtue of their being isolated so as to retain common distinguishing characters. When there is no such isolation, stock landmarks break down, and all the adjoining populations mingle to spread their characters throughout the fused population. This is exactly what happened in the white variety through numerous and continuous migrations and intercourse. Admittedly, some biologic characters are more common in one group than in another.

So far as the white variety is concerned, social classification on the basis of nationality or nation is the only feasible one. It aids us in placing a given individual, in identifying him with a cultural group and tradition. Obviously it tells us little about his biology, but for that much study and analysis is required since only a statement of his genic constitution is a dependable indication of his biologic makeup. If a superficial description is required, that description has to correspond with the characters of the given individual. Hence it can best be obtained by inspection, because of the infinite variation in the external appearances of individuals in any group. National affiliation, however, has definite linguistic, geographic and cultural meaning common to all members.

CHAPTER VII.

The Science of "Human Nature"

A great deal has been said and written about "human nature," yet very few people have ever stopped to define it or analyze it. In fact, because of its unclear and confused meaning it has become the safest shield for vagueness, ignorance and charlatanism. Whatever criminal act of murder or oppression some people find it profitable to justify, they will invariably evoke the time honored standby of "human nature." When pressed for a definition they will accuse the questioner of quibbling, dogmatism and similar crimes.

Not only does the phrase need to be defined, but it must be clearly analyzed. Human nature cannot refer to anything else but human behavior, the sum total of human responses and actions under different circumstances. As such it comprises many components which must be carefully isolated and examined.

1. The first component of human behavior is what we may refer to as the institutional factor. By this we mean that for some reason or other a custom or tradition becomes established in a given community and as such exerts a very powerful influence on the course of action of those under its sway. *This custom is obviously only a man-made institution and is not at all claimed to be a biological law or necessity.* It should be understood that the division introduced here is entirely arbitrary and made for convenience.

Such institutional factors in human behavior are the wearing of the veil by women in Mohammedan countries, particular forms of religion or patriotism, non-eating of pork by Jews and Arabs, circumcision, the vegetarianism of the Hindus, etc. The Mohammedan belief that women must not reveal their faces to any man but the one who paid for them is clearly not claimed by the Koran to be a biologic law but a religious precept. This makes its analysis easier and less burdened with confusion.

That the concept of the veil is a strong force in the behavior of Mohammedan adherents can easily be seen from the fact that in the Mohammedan parts of the Soviet Union many fathers killed their daughters rather than allow them to besmirch the good names of their respective families by discarding the veil. They claimed they would not mind if their daughters became prostitutes, but a disgrace like the one that befell them they could not endure. Much individual, social and political misery was caused by the operation of this tradition.

No philosopher as yet has claimed that it was "human nature" to wear a veil, or that "science tells us", etc. The self-styled children of Allah state openly, as do the Jews concerning their dietary laws, that it is easy to follow natural laws, but the real test of devotion and obedience to God lies in executing orders we do not comprehend.

Because the wearing of the veil, or the Jewish, Hindu, or all religious dietary laws are remote problems to most of us, we should not for a moment belittle the significance of the function of such forces in evoking human responses of strong emotional intensity, and in producing socially significant actions. The emotional response evoked or the act committed when the stimulus is an institutional force is of the same nature as the response to a presumably biologic cause. It is only the nature of the stimulus that differs, not of the response.

The institutional factor of human behavior is mentioned separately and first because it is easy to isolate and examine. Once pointed out, it can readily be seen that as a component of human behavior it is entirely social, man-made and accidental and not really human-biological. It can easily be changed, abolished, or forgotten not so much by the generation accustomed to it as in a historic sense.

2. The second component of human behavior is more difficult for some people to analyze. It involves forces that are environmental-as-if-biological. To this group belong all the behavior patterns which many of our politicians, journalists and professional philosophers attempt to justify with the final verdict "but such is human nature."

Let us examine such behavior as *greed*. Many popular writers and journalists, like Freud and Spengler or the psychologists of the popular press, talk of the possession instinct, the desire for wealth, etc. Greed, they say, is natural and, as Freud prophesies in his "Civilization and Its Discontents", will form an insuperable obstacle to any attempt at Socialism. ("I do not know anything about economics but psychology tells us", etc.)

In many poor localities where water is expensive and the bulk of the population is unbelievably poor, everyone tries to save money by collecting as much rainwater as possible while the opportunity lasts. Since there are only a few drainpipes in a crowded house or courtyard, bitter fights often ensue over the privilege of placing a container beneath the pipe. Whoever can, fills all pails, pots and dishes with water and will work assiduously until the last container is filled. Often the fights over a place at the drainpipes develop into real battles of tongue or fist.

"Such is human nature," say Freud, Spengler, and other such ignorant writers on the subject of human behavior. "Man will always be greedy, a victim of his lust for wealth, weighted with instincts of possession and aggression, showing no mercy to his fellowman when the latter stands in his way. Man is a greedy, predatory animal." Such ideas form the accepted notion of human behavior in a society built on the morals and ethics of the Stock Exchange.

Yet, let us consider a changed environment and see what happens then to the greed and hoarding instincts and the desire for wealth. In most modern cities, where many of these people or their offspring now live, the price of water is included in the rent, so that it forms no item of expenditure. Do people show greed for water there? Do they try to hoard it? The answer is—*no*. They are very liberal with it and will offer it generously to any passerby.

Yet they surely are not provided with a stock of water in the house. What they have is merely a faucet, which represents in reality only one thing, namely, security. They know from experience that the supply of water need cause them no anxiety, that if they have the rent to pay, they need not give another thought to water. They therefore show neither greed for water nor a desire to hoard it, nor any other nonsense that muddleheads or political apologists try to cloak with the phrase "human nature".

The same type of confused and dishonest thinking permeates all other talk of "human nature." In fact, the phrase has been employed so much as an excuse for vagueness or as an apology for all kinds of crime that its use should legitimately provoke suspicion in us concerning the honesty and intelligence of those who use it.

It is most significant for the reader to tabulate as many behavior patterns as possible and subject them to close scrutiny. The first group will present no difficulty because its constituents are totally accidental *in form,* and external in nature. It is this second group that embraces such behavior as militaristic behavior, racial antagonism, monogamy or polygamy as "natural" institutions, jealousy, love, "innate" religious sentiments, the praying instinct, etc., etc., that will be difficult for many to evaluate.

Let us consider, briefly, jealousy, defined not in the sense of feeling hurt at unreciprocated love or loss of lover, etc., (we all feel bad under certain conditions), but as a feeling of anger at the object of love because of his or her temporary relations of one kind or another with other people. It is claimed that jealousy as here defined is "human nature" which nothing can change.

Actually, it does not require much learning or acuity to see that under polygamy, jealousy as such could not have existed. When a Mohammedan, who is the proud owner of four wives and, let us say, fifty concubines, all dearly paid for and in accordance with the law, makes love to some strange woman, surely members of his own female collection are not going to feel hurt just because their master flirts with a girl he has not paid for. Jealousy, under such conditions, is out of the question. On the contrary, most often in such circumstances, when women are enslaved and more oppressed than cattle, they are only too happy when their master brings another slave to the house, an addition that must relieve their burden.

Hence in all of these behavior patterns, accepted by many as biological, we must carefully study the same phenomenon under different conditions and determine whether it is really so. That process will be more clear after the discussion that follows.

3. The last type of behavior involves what we must call biological, that is, consistent, physiological, psychological properties of the organism. Under this heading would come all human be-

havior existing as a necessary consequence of man's physiological and psychologic makeup, such as all sense perceptions and sensory responses, reflexes, hunger, pain, sex, the desire for sociability or for knowledge, the capacity to respond to artistic stimuli, etc.

It would be false to assume that biologic behavior, once in effect, cannot be modified. Quite the opposite. Theoretically speaking, everything can be modified when the proper conditions for change are known and attainable. Also, the degree of modification varies in different instances.

It is convenient to divide all biological behavior into modifiable and unmodifiable, remembering that this is a relative and arbitrary, yet in many ways helpful division. The fact that some behavior is biologic does not mean it is unalterable and final. It is well known that within limits one can modify one's responses to pain, hardship, abuse, oppression, less food or sleep, and so forth. There is no doubt, however, that sensory responses and the quality of sensations cannot be modified. So long as we have eyes we shall see light, so long as we have ears we shall hear. The same applies to taste, smell, pain, sex. etc.

As an illustration of how biologic behavior can be modified let us consider the well known case of conditioned reflexes. A reflex is an animal's active response to a stimulus. When a man's hand is touched with a hot needle, a rapid muscular contraction ensues and the hand is withdrawn. Reflex action involves the following components: the applied external stimulus, in this case heat, the receptor, here the heat-sensitive cells of the skin; the sensory nerve, that is, the one leading from the receptor to the spinal column or brain which form together the central nervous systetm, also a component; next the motor nerve, that is, the nerve issuing from the central nervous system and going to an effector, an organ performing some activity. Every organism possesses by virtue of its physiological makeup a number of innate "natural" reflexes such as the knee jerk, fear, tickling, the salivary reflex, etc. Not all reflexes need go through the brain; some traverse only through the spinal column as can be seen in the case of the reflexes shown by a decapitated frog.

Innate reflexes, however, can be changed. The mechanism of their modification has been studied by the famous Russian physiologist, I. Pavlov. It is well known that a hungry dog secretes saliva at the sight of food. Man even secretes it at the mere mention or thought of it. Pavlov made an opening (a fistula) in the salivary gland of a dog, inserted a small glass tube protruding to the outside and allowed the wound to heal. He could then observe the salivary reaction and measure the number of drops produced, as well as time of origin of secretion. By this method he discovered that if a bell were rung just before food was given to the dog and this combination repeated a sufficient number of times, the dog would become so conditioned to the sound of the bell as to secrete saliva when it heard the bell only and when that was not followed by food. In other words, a given response, namely, the secretion of saliva, was now linked with a stimulus—the sound of the bell—to which it did not respond "naturally", that is, by virtue of makeup, but was made to do so experimentally, by virtue of training and reorientation.

While the original reflex, namely, the secretion of saliva at the sight of food is called the unconditioned reflex because the animal gives it biologically, without experience, since it is so constituted as to give it, the man-made is called the conditioned reflex. The study of such behavior has revealed a vast amount of information concerning the operation of nerve paths in the brain, the meaning of habit, training, association and inhibition. It also forms a fundamental concept in any approach to a study of social behavior.

The vast deal of experimentation conducted on conditioned reflexes indicates beyond a doubt that that part of the brain which is the seat of consciousness is practically a blank at birth. All subsequent paths are laid down by means of association, habit and complex conditioning. Analysis of social behavior proves independently the man-made nature of most of our social ideas and acts.

From this examination of human reactions it is clear that any behavior patterns in man must be subjected to a close scrutiny before its nature can be determined. Before we decide that something is biological, we must eliminate first the institutional factor, which is easy by virtue of its complete remoteness from biology. Even when some behavior is claimed by many to be biological we must examine it under different social and economic environments to see whether it is not socially induced. When we find that it is biological we must still ascertain whether it can be modified or reconditioned or not.

In general we must bear clearly in mind that the really complex and difficult cases of behavior are those in which a fundamentally biological or psychological reaction becomes so modified by social environmental forces that the two components produce a complex fusion effect. The result of such an interaction is that as a rule the biological basis gets lost in a maze of forms which, though social and accidental in nature, are taken to be immutable expressions of the biological response. For example, sex is definitely a biological phenomenon. The social forms, however, into which sexual intercourse is forced in different countries and periods, differ widely. The forms are purely social, environmental, and in some aspects accidental. The sex desire itself is biological.

The same holds true for the response to artistic stimulation. We all, statistically speaking, respond to and in a way desire music, stories, songs, dancing, pictures, carvings, etc. The variety of forms which these works of art can assume are not determined as such and depend on custom, tradition, technical level, art beliefs, the originality and individuality of the artist, his social outlook, economic sympathies, etc., etc. The most important task in analyzing human behavior is to separate the biological basis from the forms the given reflex, need or desire may assume under different social, economic, or moral environments.

It is advisable to define at this point the word "instinct" and show how it has been misused by many self-styled scientists, particularly Freud and his "school". Instinct is assumed to mean a complex behavior pattern innate to the organism. It must be in the nature of a response to external stimulation or to internal, such as hormones. It is neither taught nor conditioned, but is, like a reflex, a property of the organism as physiologically constituted. It differs from a reflex in that it is more complicated and involves more than one isolated act, usually a chain of actions that give the total behavior pattern a semblance of intelligently guided or purposive conduct.

Even if we define the word "instinct" and understand its meaning, we may still encounter great difficulties in verifying it or detecting it. The following illustration will be instructive. We all know that dogs seem always to pursue cats and try to bite them. The widespread nature of such behavior makes us believe that dogs are born with an instinct for hating cats. While such a response to cats on the part of dogs does not go contrary to the laws of nature, recent experiments deny such an interpretation. It was found that when a puppy is taken away from its mother a few hours after birth, brought up in complete isolation and returned to animal society upon reaching maturity, it will never try to pursue cats or show any animosity towards them. Apparently the usual canine behavior is strongely determined by imitation of other dogs, by social-environmental customs or practices. It has, of course, been known for a long time that dogs can be brought up to live very amicably with cats. One might think that it was a reconditioning of an existing cat-hatred instinct. The experiment cited proves that none such exists.

Hence, in using the word "instinct" we must be as careful as with the term "human nature", not to take superficial phenomena for granted, but look more deeply into the situation. Unfortunately, a great deal of confusion and ignorance has resulted recently from the writing of Freud which, due to their fantastic, sexy, individualistic and unscientific nature, gained wide appeal and acceptance. Since most of Freud's writings deal with "human nature" and "instinct", and since their author still has a few adherents, brief mention of his views and methods will not be out of place.

Freud's approach to human behavior differs from the one adopted here in that it is not based on any scientific analysis. Freud seems to be totally ignorant of the findings of genetics, or the study of sensory, nervous or brain psychology, to say nothing of reflexes, either conditioned or unconditioned. Nowhere in his writings is there any evidence of such knowledge. Nowhere in his writings is there a single controlled scientific experiment. Nowhere is even one of his theories ever put to the test.

Freud's method is that of gossip. While any great scientific thinker can only boast of a few theories, Freud enunciated well over a thousand. No sooner is what he considers a fact announced, than hard upon its heels follows a fantastic theory, couched in such muddled terms that testing it is out of the question.

Here are some of Freud's theoretical conclusions. "Civilized society is perpetually menaced with disintegration through this primary hostility of men toward one another." "The tendency to aggression is an innate, independent, instinctual disposition in man . . . and constitutes the most powerful obstacle to culture." "Every individual is virtually an enemy of culture." "Men feel as a heavy burden the sacrifice that culture expects of then in order that a communal existence may be possible." "Culture must be defended against the individual and its organization, its institutions, its laws are all directed to this end." "Every culture must be built on coercion and instinctual renunciation." "There are in all men destructive, antisocial, anticultural tendencies." "As we have long known, art offers substitutive gratification for the oldest cultural renunciations, still always most deeply felt, and for that reason serves like nothing else to reconcile men to the sacrifices they have made on culture's behalf."

These quotations are not selected but form a random sample from a few of his books opened at random. His writings consist of nothing else but such statements. It is on such reasoning that he divides human life into three stages of sex, the oral, when the child sucks at its mother's breast, the anal, when it dirties diapers and craves for its anus and fæces, and the organ stage, after the first two are overcome. On similar evidence he reaches the conclusion that the origin of private property is nothing but fæces, the first object coveted by a child. The yellow colors of fæces and gold are given as further evidence of their relation, as is also the fact that patients of psychoanalysts, who refuse to pay the price demanded, become invariably constipated because withholding their money results in withholding their fæces!

Consider Freud's elucidation of the origin of man's control over fire, of the emotional connotation of flames, and of the evidence proving that woman's place is in the kitchen. "Flames shooting upwards like tongues were originally felt to have a phallic sense. Putting out fires by urinating . . . (consider the logic —M. G.) therefore represents a sexual act with man, an enjoyment of masculine potency in homosexual rivalry. Whoever was the first to deny himself this pleasure and spare the fire was able to take it with him and break it into his own service. By curbing the fire of his own sexual passion he was able to tame fire as a force of nature. The great cultural victory was thus a reward for refraining from gratification of an instinct. Further, it is as if man had placed woman by the hearth as the guardian of the fire he had taken captive, because her anatomy makes it impossible for her to yield to such a temptation. It is remarkable how regularly analytic findings testify to the close connection between the ideas of ambition, fire, and urethral eroticism."

Such is the mode of reasoning of a man who is claimed to have made contributions to psychology or medicine. Freud's only contribution consists of the above sample multiplied a hundred thousand times and dealing in the above indicated manner with whatever subject he happens to think of. His popularity is nothing but a sad indictment of the scientific and philosophic corruption that individualism has wrought among large numbers of so-called intellectuals.

A few words should be said about the method of the behaviorists, their contributions and limitations. The behaviorists take a stand which is contrary to that of the psychoanalytic myth. Their approach is basically scientific even if in a limited sense. They rendered great service to the study of behavior in opposing introspectionist ideology or any loose talk about instincts, desires, complexes and other undefined terminology. Behaviorists insist on a physiological approach, on operational definitions of all terms used, on experimental verification and analysis of all psychological postulates. They see that it is impossible to separate psychology or the study of human behavior from the anatomy and physiology of the human organism, and that all these aspects of the organism must be studied simultaneously..

Yet the behaviorists fail to think dialectically and do not see the subject in its proper perspective. Their opposition to the confusion of the introspectionists led them to the other extreme of seeing only mechanisms, and of overlooking the significance of new qualities produced by different arrangements and different situations.

Behaviorists pride themselves on their reducing all behavior to terms of chemistry and physics. They therefore refuse to study psychological responses, the mechanism or physical basis of which are unknown at the time. They do not see the dialectical principle that each new situation has a system of coordinates all its own by virtue of its creating something qualitatively novel. A knife held in one's hand forms a qualitatively different situation from one in which a knife pierces one's hand, the same components, the knife and the hand, being involved in each.

No doubt all psychological behavior must have a physical basis. Different reactions must occur along different paths when one experiences painful or joyful emotions. Yet these feelings, once brought into being, have an existence of their own, for practical purposes independent of their physical basis. A trade unionist or a scientist undergoing inhuman tortures in a Nazi concentration camp is little concerned with a mechanical and obviously irrelevant report that at a given time his gastrocnemius is receiving that much pressure or his femur pulled from the acetabulum with a certain force, etc. The pain he experiences, the pain of his friends, the destruction of benefits and social institutions he worked for, the desire to overthrow his brutal enemy, his behavior, emotions and thoughts under the circumstances—these are the psychological facts relevant to the situation. Naturally every human thought or emotion must have a different nervous path or combination of paths, must have a physical basis. It must also be admitted that knowing this physical basis will obviously be helpful to the understanding of the situation as a whole. Yet we cannot overestimate the fact so well borne out by sensory physiology that changed quantitative relationships produce new qualities, having new properties, new values and demanding new approaches. It is sterile mechanicalism to do what behaviorists do with their gospel of physiochemical phenomena, quantitative precision, etc., etc. Human behavior assumes many subtle and complex aspects, particularly as an organism which interacts with social environmental forces of great variability in content and multiplicity in form. The student of behavior must follow the subject wherever it leads and not adhere blindly to mechanical principles. Any situation clearly outlined, in terms operationally defined, is subject to scientific study, and must not be snubbed only because we cannot apply to it expensive apparatus that the investigator happens to own. Human behavior of the complex kind as well as social behavior can be studied just as precisely, just as scientifically as physiological responses. The same tools cannot be used for all situations. The study of social behavior is particularly significant in view of its aid in social reorganization affecting the welfare of all human beings and their pursuits.

CHAPTER VIII.

Heredity in Man

In our previous discussion of heredity we have referred to man very seldom, if at all, because very little happens to be known to date about human heredity. The reasons for it are not far to seek. Genetics is a young science and the life span of a generation in man is relatively long. Descriptions of ancestors on the basis of records or memories are not dependable. Experimentally, very few cases have been traced for several generations. The number of offspring is small and, in addition, the environment can vary so frequently and so radically as to affect basically many characters or the survival of their bearers. No planned experiments are possible since human beings cannot be mated according to the geneticist's wish. The geneticist has to find the experiment which he is interested in and study it as best he can.

It goes, of course, without saying, that whatever is true for other animals holds as well for man since man is a part of the animal world. Carefully tested conclusions of broad genetic analyses tell us that all aspects of an animal's life and functions which depend upon a biological basis are determined by genes. We shall see that that holds true for man as well. Similarly all human characters must have arisen by mutation, and also human stocks and varieties, in the way outlined in a previous chapter.

Particularly after our analysis of the meaning of human nature are we in a position to examine precisely what is and what is not inherited in man, because we are enabled to separate the biological from the socially environmental. Such a division forces us to admit that all biological behavior is the consequence of structural and functional differences. Genetic evidence tells us that all such differences are determined by genes, from which it follows that differences in fundamentally biologic behavior are determined by genes, hence are hereditary in nature.

There are two forms of behavior in man which on the basis of the above reasoning must be considered hereditary, namely, *capacity* and *temperament*. It should always be borne in mind that by hereditary we do not mean that the offspring must show the same character as the parents, but that a given character is determined by genes. These two behavior forms must be carefully defined so as to admit no confusion.

By capacity is meant the highest level of skill or excellence achieved by a given individual under conditions of the best possible environment and training. It is known to all of us that if we take a given number of individuals, say young boys, and give them identical and excellent training in either singing, sprinting, violin playing, painting, writing, mechanical work, etc., they will not all be alike in their efficiency in the particular craft. If we take singing as an illustration we shall find that a few have excellent voices, a few will be monotones, and the majority will be just about average. The same numerical relationship holds true for any other occupation mentioned. In fact this type of numerical distribution has been called the *population distribution curve*. It means that if we consider, let us say, height in man, and study its distribution in the population, we shall find that very few individuals are eight feet tall, a few more are seven, with gradually increasing numbers for six and a half and six. There will be a maximum, that is, the largest number or the mean, around five feet six or seven inches. For values smaller than that, the number of individuals will keep on decreasing until we reach extremely small numbers for small sizes, say three and a half or three feet. These heights will be represented by very few individuals.

For any human capacity we may consider, we shall find this distribution curve. When a sample of the population is taken at random and classified, we find wide limits of variations. This is so because the environment varies together with the biological makeup of our material which was chosen at random. Experiments show that if we take such material and control the environment our distribution curve will have narrower limits and will become more regular because it will only reflect the biological variation in the genetic makeup of our material. The effects of different environments will have been eliminated.

A thorough study of the meaning of such variation was made by Johannsen in 1908. He studied variation in the size of beans. He controlled the environment, grew a mixed lot of beans, and found in the crop the normal distribution curve for size. For a long period of time he kept on selecting the biggest ones, the smallest ones, and some intermediate sizes and bred those separately in an attempt to establish pure lines of different sizes. This is the same as saying that he tried to isolate different genes for size. Johannsen succeeded in that. He established races which gave different averages or mean weights and bred true for that mean. Hence his isolated lines were really different genetic types.

He found, however, that he could not do away with variation altogether. Within each line there were some differences in size of beans, even though they differed within narrow limits. Yet, he found, that in a given line, whether he planted a large bean or a small one, he invariably obtained in the offspring the same average as in the parental stock. Hence he had reached a point beyond which no more selection was possible. This type of variation we may consider inevitable or residual and is produced by a multiplicity of accidental factors which cannot be controlled.

Hence there are three component factors to each distribution curve. The first is variation due to the environment. When that is kept constant we get variation due to biological makeup, chiefly. Next, even in a pure, homozygous stock, there is still some variation, so that almost no two individuals are exactly alike. This is the inevitable or uncontrollable variation.

It is clear then, that if we make a statistical analysis of the human population with regard to any capacity we shall get a distribution curve which will be the product of all three factors. For this reason our definition of capacity requires a controlled environment to eliminate variations due to it. It is then that biological differences appear.

The genetic basis of the distribution curve for any capacity lies in the fact that the given capacity is presumably due to many genes. In such cases the law of probability will operate to produce a distribution curve of the different possible combinations. These different combinations of genes are expressed as different types. It should be pointed out here that the fact that genius is rare means that it is due to a rare combination of genes. This means that on a probability basis such a combination is not expected to occur frequently.

To return to the subject of capacity by way of summary. A carefully controlled environment brings out the hereditary nature of capacities which must have a physiological basis. It is obvious that the throat of Caruso was differently constructed and functioned differently from the throat of a monotone. The muscles of a Nurmi are different from the muscles of a trained runner who is far below Nurmi's level of skill. These biological differences are determined by genes, hence also the capacities.

Another genetic aspect of human behavior is what is commonly referred to as temperament. By temperament we mean the ease or rapidity with which a given individual responds to various emotional stimulations. Some people respond readily to such stimuli, others more sluggishly, some more violently than others. It is taken for granted that a certain amount of constancy in the environment is maintained since habit, custom or training is a great force in conditioning an individual to express or control his emotions to different degrees. It is through controlling the environment that we discover that temperament, though to some degree modified by the environment, is basically determined by genes.

Physiologically it is easy to see the structural and functional basis behind variation in temperament. It is not a qualitative but quantitative difference since even sluggishly responding individuals will react rapidly and violently if we make the stimulus intense enough. In physiology such behavior is well known and has been thoroughly studied as *threshold* phenomena.

By threshold intensity we mean that stimulating intensity which is just necessary to evoke a response. Intensities stronger than threshold will, of course, be effective, while any below it will fail altogether. All sense organs, nerve and muscle, show threshold behavior. A nerve or muscle fiber either responds to a given stimulus or does not. When it fails we say that the stimulus is below threshold. We may take light for an example. A person may be confronted with an extremely weak light which he cannot see. As the light is increased a point is suddenly reached which can barely be seen. That intensity is the threshold.

A muscle or nerve consists of many fibers, that is, cells, which have a wide distribution of intensities according to the distribution curve. This means that there are few fibers that have very low thresholds (very sensitive), few that have very high thresholds (less sensitive), with the majority of fibers centering about an average intensity. The fact is that when we see more light, feel more pain, taste more sugar, etc., it is because the stimulating intensity is sufficiently high to reach the thresholds of a large number of cells. Intensity of sensation or response is evidence of more cells operating because more thresholds are reached.

Without going further into this problem which presents many interesting aspects, we can see that temperament is not a vague figurative term but has real meaning if we view it against a background of physiological thresholds, which are well-studied phenomena.

Of course, the type of reaction which we call temperament is not merely sensory or structurally physiological. It is primarily psychological, that is, central nervous and more complex. Nevertheless the same relationship of stimulus and response exists as in the case of applying an electric shock to muscle, light to the eye, sugar solution to the tongue, etc. In either case, sensory or complex-phychological, we can vary the intensity of the stimulus and correlate it with a respective variation in the nature of the response. By following the same technique as with the sensory or muscle-nerve physiology we can study equally well psychological or emotional responses, though we do not know exactly either the seat of the specific brain center or the number of neurons and lengths of path involved.

Genetic studies indicate that these two forms of, if you will, mental behavior are the only ones that are determined by genes, the only ones that have a biological basis. All other forms are social-environmental and should be analyzed according to the plan outlined in the previous chapter.

The question that can now be raised is—what are mental traits? The answer is that the phrase is as vague as "human nature" and unless carefully examined and defined is not only meaningless but a dangerous source of confusion.

We have by now practically covered all the salient points concerning the elements of human behavior. We find that the term mental behavior means exactly nothing. The fact that somebody chooses to call a certain form of behavior a mental trait means that he is not analytical or is unaware of an available method for the determination of the nature of any behavior form. We must take that behavior pattern designated as mental trait and subject it to the test of the outlined procedure. We must establish first whether it is the product of an interaction between a biological base, and social forms, whether it is at all biological, and finally, the degree of its reconditioning capacity.

We must remember that in man we are confronted with social values, which must always be considered when the question of behavior is at issue. We cannot be altogether detached in studying human behavior but must consider it from the viewpoint of society by which it is completely modified and evaluated. It is for this reason that it is part of our routine description of a behavior character to state its social implications and value.

Most pseudogenetic writers who deal with the inheritance of mental traits talk sheer nonsense. Their first task should be to go through the institutional and social maze of influencing forces and separate the social from the biological. This they do not do. Their second task should be to establish the gene for the biological base after they find it and describe it in careful terms. This is a difficult task in man and requires much genetic skill, patience and material. This, those writers surely never think of doing. Why determine the gene for a given biological or psychological function when it is so much easier to write a book about it that will pass as illuminating profundity among the decrepit searchers of "ennobled races" and "superior beings"?

Human genetics has been studied very little though it is much talked about. We know that mutations arise in man as in other animals. There are mutations that affect every structure and function in the body. They do not survive as readily as in other groups because of social standards of normality. As pointed out before, genetic studies in man are very difficult and require ardent labor which no amount of glib talk or popular treatises can replace. In the silence of the laboratory some work is going on, however.

An interesting mutant race was discovered in man recently. A certain chemical substance was found by some people to have a very bitter taste and by others to be perfectly tasteless. Upon making a statistical study of the distribution of tasters and nontasters in the population it was found that they were in a ratio of three nontasters to one taster.

Another instance of inheritance of a sense organ is color blindness, a sex-linked recessive. Surely color perception and tasting of specific substances is a significant part of behavior. Both cases mentioned are due to single genes behaving in every way like recessives in other animals. The same holds true for many other single gene characters studied.

A few well controlled statistical analyses of human data have been made. They prove that quite a number of deformities and diseases are inherited. Such are hæmophilia or bleeding, a sex-linked recessive, brachydactyly or short-fingered condition, albinism or absence of pigment, ateliosis or true dwarfism, multiple sclerosis or degeneration of nervous tissue, congenital deaf-mutism, Huntington's chorea, etc. A common character easily studied is brown eye color which is dominant to a particular blue and behaves in the usual Mendelian manner.

The case of skin color is not as simple because skin pigmentation depends on many genes. The so-called "white race" is really gray and not white since white by right means albinism. Members of the white variety do have some pigment in their skins. Moreover, within the white variety there seem to be many genes for pigmentation. The pigmented types of *Homo sapiens* form a continuous series from albinism, through the various types of white, to deeply pigmented types. The indications are that many pairs of genes are involved.

For this reason we get such a wide distribution of types of mulattoes. Hybrids between Negroes and whites will contain varying combinations of the several color factors carried by their parents. The multiplicity and variety of shades of skin color are due to the multiplicity of factors involved and the variety of their possible combinations. Such continuous quantitative variations are invariably a sign of a case of multiple genes, as in the case of height, capacity and similar variables. Particularly when mulattoes are inbred the genes for color are so shuffled about in the production of egg and sperm as to result in a large variety of colored types.

Even on the physical characters of man few experimental analyses of value have been performed.

When we come to the genetics of capacities or temperaments we find that no experiments whatever have as yet been done. These are genetically more difficult cases, because the wide gradation existing in each case is alone sufficient to indicate that many genes are always involved. Instead of doing experiments, however, many "race philosophers" and "population specialists" find it more profitable to write books or essays. As a result there has lately been apparent a proportionate rise in the general confusion on the subject.

It is possible that certain characters may be more common in one stock than in another or that certain capacities may be more widespread in one biologic group than another. Let us suppose that we find it necessary to compare such groups on a basis of biologic characteristics. How shall we go about it?

There is only one answer genetics can offer to this question, namely, by means of the statistical method. The method of making generalizations of the kind commonly made is confusing and based on ignorance or malice. It is imbecilic to say that all Germans are blond or blue eyed or both, or vulgar, or mercenary, or noble. The same for any other group. It is equally useless to say that the majority of one group or another possess a given character. Mutant characters arose at different times in different populations and are spreading at different rates. *In order to state intelligently and accurately the composition of any biologic or social group it must be expressed statistically in terms of percentages.* Only then do we get a picture of the makeup of a group, so far as a particular character is concerned, and only then can we compare different groups with each other.

The statistical method of describing the biological composition of stocks of a given variety holds true for physical characters as well as for those relating to behavior, namely, capacities, temperaments, sense organs or inherited reflex differences. It goes without saying that while a statistical statement of the proportion of blue eyed individuals to brown eyed in Italy or Germany is a clearcut bit of information, the same cannot be said about the percentage of competent physicists in Iraq and England, for example. In the case of capacities and other similar characteristics where the environment is most significant, it is obvious that no comparisons whatever can be made when the environments differ. Clearly it is impossible to state how many competent violinists exist in a given Eskimo community if no inhabitant has ever seen a violin, let alone tried his skill at it. Unfortunately, statements based on ignorance are not only common today but bewildering in their impudence.

It is possible to compare the distribution of any physical, or social psychologic characters in any human groups provided we obey certain fundamental rules. If, for example, we want to find out whether the Germans are greater music lovers than the Italians, we must begin first of all by elaborating a scale of measuring love of music. This is inevitable since we know that there are different degrees of such love and that the problem must be handled statistically. After a practical scale is accepted we must make a study of the distribution of the various kinds of love for music in each of the two groups and compare the two curves. We may find no differences at all, or we may find differences in only one or two regions. Anyway, without such a procedure no comparisons can be made.

It is not expected that people will adopt this method, which, to say the least, requires more work than making statements in the tone of a sage or scientific authority. It is our duty to point out to those glib announcers that their method is unscientific and misleading.

CHAPTER IX.

The Eugenic Program of Superiority and Sterilization

The confusion promoted by the concept of race, indicated in a preceding chapter, has been exploited very extensively for political purposes and is being done so with particularly tragic results in Nazi Germany and the United States today. The word "race" came into popular vogue in the seventeenth and eighteenth centuries, when the conquests of colonial nations and markets took on large proportions and when imperialism took root. Imperialist nations found it convenient to defend their criminal aggression by taking advantage of the biological and civilizational differences between them and their economic and political victims to abuse the latter as much as possible. This they did in the infantile and straightforward manner of claiming that they, the imperialist conquerors, belonged to superior races, while their victims were obviously inferior.

There is hardly a criminal practice that has not been defended by our reputedly cultural leaders, professors, philosophers, ministers, bishops, politicians, journalists, scientists and artists in thousands of books, essays, sermons, poems and what not. Not only is race no exception, but because of its tremendous economic significance, it forms the best illustration of the servility of hired writers and of the corruption of science and learning by vested interests. Literally thousands of books, to say nothing of sermons, essays, etc., have been printed with all kinds of fantastically stupid and antiscientific proofs of the inferiority of the Negro. East Indian, Arab, Chinese, Syrian, etc., etc., as the situation required.

An entirely new so-called science has developed around this occupation. It was named "eugenics" or the science of being well born. As a science eugenics showed remarkable practices and development. While other sciences accumulated facts first and subsequently attempted to unify and coordinate them by means of theory, eugenics introduced a touch of piquant uniqueness by doing the reverse, by enunciating hundreds of theories and forcing facts into them. As young as the science is, it already has more theories than genetics, astronomy and geology put together.

Another unique characteristic of eugenics is that, unlike other sciences, common agreement on facts or theories are never striven or hoped for. On the contrary, eugenists take it for granted that each one of them should glorify his own so-called race. Particularly during a war, eugenic investigators on opposite sides of no man's land are "doing research" at a tremendous pace ascribing all kinds of bad and vulgar attributes to the "enemy" and kind, noble and flattering attributes to their own national type. The daily press becomes during such periods very scientifically minded so far as eugenics is concerned and gives prompt and wide publicity to its findings.

A third distinguishing characteristic of eugenics is that, unlike other sciences, it has a program. Eugenists act openly and admittedly as members of a society with a program rather than as fellow investigators in a given field of research. Their program too, is fairly simple, and represents a literary transcript of the philosophy of any prosperous merchant and farmer of the South or of the leading members of a rotary club, a Sunday school or a regular political club. In brief, the eugenists' credo is the following:

The human species is divided into "races" chiefly on the basis of skin color, although wherever necessary other characteristics may be evoked, such as eye color and formation, straight or curly hair, shapes of skull, etc. While eugenists are not at all certain about the inheritance of many physical characters they are quite determined in their belief that the so-called mental traits are not only inherited but characteristic of different "races." Some races are "superior" to others and as such are duty-bound to "civilize" the more backward and inferior ones, as was done, for instance, by the British, Dutch, French, Portuguese and other missionaries, adventurers and slave traders in Africa and other continents.

Subject races should not be exterminated but used for rough labor the way a farmer uses cattle, says Hitler in his book, "Mein Kampf," in a eugenic chapter entitled "Race and Nation." Professional eugenists would put that more eruditely and more diplomatically. The inferior races are not competent to govern themselves, hence imperialist armies and navies must do it for them. Intermarriage between races is a very harmful practice and, to quote Hitler again, "Each cross between two not equally high animals results in an intermediate between the heights of the two parents. That means then: The offspring will stand higher than the racially low member of its parents yet not as high as the higher one. Such pairing, however, goes contrary to the will of nature striving to produce higher types." The hybrid will lose in battle with the higher parental type, says Hitler. This statement is then followed by a moral—"The stronger must rule and not fuse with weaklings at such a sacrifice."

Having proved that the group of which the particular eugenist considers himself a member is superior to all others, the eugenist then proceeds to announce that the vast majority of that very same group are of very low type indeed and should be quickly and forcibly kept from multiplication. That menacing biological herd is nothing else but the working class of the country, who show by their very membership in that class that they are incompetent, brainless and devoid of any valuable biological properties. Little indeed is being written today about the inferiority of the colored races. This is done only when the situation becomes particularly acute as in the case of open uprisings or culminations of powerful mass movements for colonial liberation.

If one examines the eugenic writings of today one will find that the subject is entirely a class affair. No British eugenist has ever suggested that Indian princes or wealthy merchants should be sterilized. He will, however, rave with inspired passion against the lower classes of England, British flesh and British blood, who dare multiply while the professional and upper classes, presumably biologically well endowed with valuable capacities, practice birth control and deprive the world of brains and talent. Intermixture of races is considered by eugenists to be very bad taste and "to lower" the hybrid, but that does not apply to royal families or to millionaires. It seems that not only does a workingman have no country but he has no race, to use their own terms.

Since the concept of race had never been used in biology and was never scientifically defined, it was easy prey for politicians and journalists to exploit it for their own purposes. Consider hybridization in the United States, in South America and South Africa.

In the United States the saying goes that a drop of Negro blood, figuratively speaking, makes an individual a Negro. Looks do not count nor time of duration of interbreeding, that is, whether the given individual is a third or tenth generation hybrid. In South America the reverse is true. There the saying became established that a drop of white blood makes one white. Anyone who can discover a Spaniard in the line of his ancestors is considered white and is entitled to join any exclusive golf club, provided he is sufficiently wealthy.

In South Africa an entirely different situation prevails. The non-white population there constitutes approximately eighty percent of the population, a delicate situation indeed for effective exploitation and oppression. A new philosophy was therefore introduced, and has proved very useful so far. The non-white population is divided into two groups, Native and Colored. The Natives or Black are unmixed stocks, the Colored are mulattoes or hybrids. The two groups are kept entirely apart. The Colored have some privileges, are allowed to vote, to go to school, and can hold certain jobs. The Natives are not allowed to vote or go to school, cannot be out after sunset, cannot move from place to place or travel. They are in fact in a condition of slavery. The Natives and the Colored live in different ghettos, and intermarriage between the two groups is unthinkable. They will never as much as eat at the same table. The antagonism between them has been raised to such a pitch that they pogromize each other on occasions and have established a "tradition of hostility" that sterile professorial historians love so much to talk about.

It is easy to see that the lines of demarcation between Native and Colored are not always sharply drawn. What often happens is that when a hybrid child is born to a Native woman, usually resulting from rape by a white man who can never be punished for it in South Africa, the mother will try her best to abandon the child in the Colored section or help it later in life to sneak into

Colored society. All this in the hope that the child would have a better life than the mother even if it means denying truth and whatever affection it may have for its people. Conversely, a Colored who resembles a Native is at a disadvantage.

This is only one instance of the origin of racial philosophies and serves to show how their nature is completely determined by economic needs and circumstances. As agents of capitalist ideology, eugenists find always the social setup in harmony with their concept of science. The division into Native and Colored races finds approval in hundreds of books and pamphlets which tend to prove that all is as it should be, and in the name of science, of course.

The information presented in the preceding chapters should enable the reader to see the fallacies and stupidities of the eugenic speculation. Anthropologists have made important contributions in exposing the unsound claims of eugenists and other racial philosophers. They are, however, guilty of one serious shortcoming, namely, a failure to give a substitute theory to account for the obvious, biological and social variation that does exist. It is not enough to refute stupid and harmful social theories by showing their inability to explain this or that event or their inaccuracies here and there. Socially it is important to realize that the potential adherents of the false theory are familiar with the facts even if superficially, and do wish to have an explanation for them. Not offering a substitute theory puts them in a position of being easy prey for falsehood and for political traps.

A substitute theory is offered here. It has been made possible by a dialectical analysis of human society where two forces interact to produce a complex synthesis that must be understood. The two different forces are biological variation and social formation which *interact to form varieties and stocks superimposed by nationalities, which are social phenomena. Only when we see the dialectical interaction between biologic and social forms, together with a clear picture of the economic and political forces which determine the mode and rate of social development, can we have a clear understanding of the situation. By shunning a social philosophy on the one hand, and by being unfamiliar with genetics on the other, anthropologists are simply wasting great efforts in petty refutations that are neither effective nor scientifically fundamental.*

Variation is the most universal law of nature. This applies to biological as well as to cultural or social phenomena. Take ten groups of the same identical type of animal, settle them in ten isolated spots and examine their offspring after a hundred generations or so, and you will find them all different, in superficial or minor characters, of course. Mutation is constantly occurring in all animals and, according to the laws of chance, different mutations will occur and spread in different populations. Hence biological differences.

Variations are equally inevitable in forms of psychological expression or in forms of social institutions. Take ten groups of children and settle them on isolated islands without any external influence and you will get ten different languages. The same holds true for art forms or communal organizations. There are some basic natural laws operating in each case but there is also a great deal of freedom in the form of expression, execution or organization. Every human being is provided with similar vocal cords but different tribal groups make different sounds in their respective languages. Sex is a physiological and psychological phenomenon, and the biological aspect of sex is the same for all human beings at all times. The forms of love making and the social organization of marriage, the taboos and values that gathered around it, differ under different traditions. Actually most of these forms are accidental though the course of and the need for a given institution are determined by economic and social causes.

Anthropologists fail to stress sufficiently that the causes of many phenomena which eugenists point to as evidence of "racial superiority" are wholly social and economic in nature. That, of course, is "Marxist talk" and "dogma" and does not seem to appeal much to their so-called broad-minded liberal approach. Consequently the attitude of the anthropologists is mechanical and narrow. Some people refer to such an approach as scientific. They seem to mean by it an attitude that limits itself to a study of petty points and refuses to see inter-connections between cultural development and the determining social forces, economic in nature.

It does not require much erudition or ingenuity to see that the Italian cities formed the seat of European art and culture in the Middle Ages because of the wealth they accumulated through commerce in which they occupied a dominating position. With the transfer of Eastern and European trading to Holland, Portugal, France and England, science and art followed. It is ridiculous to say that the so-called Nordic race is biologically more gifted than other human groups, because one may well ask—how did those endowments express themselves until three hundred years ago? For a thousand years at least Nordics had been exposed to the rich heritage of Greece, Rome and Judea with no consequences until the expansion of commerce called for and demanded more markets and goods to profit from. This in turn stimulated cotton growing, sheep raising and, above all, industrial expansion with its inevitable scientific progress. Once industrial countries are in existence, it is easy to see in practice, and of course also on theoretical grounds, that whenever they come into conflict with chiefly agricultural ones, the latter are bound to lose. The reasons for it lie in the fact that industrial countries are richer, better organized and centralized and fully equipped with military machinery, while agricultural ones are chiefly feudal, hence disorganized, moneyless, without adequate equipment and hopelessly decentralized. It is that which accounts for the conquest, for the oppression and exploitation of vast continents by such small but industrial countries like England, Holland or Belgium.

In short then, to expose the nonsense of the eugenists we must face the situation in all its complex aspects and consider all the facts which eugenists attempt to explain. We must point out the class nature of their philosophy, the political service it renders as a defense of colonial oppression, its lack of biologic and particularly genetic information, its ignorance of social economic forces as the determining elements in the shaping of cultural forms and movements, and its entire lack of scientific perspective as to the nature of human behavior and its modifying factors.

With the general analysis outlined here the reader will man age to fill in gaps, and raise and answer questions omitted. There is only one point that needs further comment and that is sterilization.

Te begin with, it should be stressed that no scientist can be opposed to sterilization on purely moral grounds, or on the basis of the vague notion of interfering with nature, etc. For the welfare of society the state has the right to execute people or deprive them of their freedom. Surely, it is also entitled to permit sterilization for the same reason. Yet depriving people of their capacity to reproduce is an act of serious psychologic and social consequences. We must therefore be scientifically and philosophically certain of the need for such action and also of the effectiveness of the step chosen.

Upon considering these two aspects of the problem we are forced to the conclusion that every member of our society must bitterly oppose sterilization today for many reasons. First, it is a dangerous weapon to give to politicians who stop at nothing in executing their task of protecting the interests of those who hired them. These politicians, who never hesitate to slaughter millions in a war for profits or for colonies, are certainly not to be entrusted with objective and scientific administration of a sterilization law. This is proved in Nazi Germany where the law can be used to permit sterilization of "socially undesirable" individuals and "criminals." These terms clearly include pacifists, Socialists, Communists, even Catholics or anyone opposed to Nazi barbarism. To make the law vaguer still, the term "slightly feeble minded" is added to the list of eligibles.

All eugenists who promulgate sterilization do it, like the Nazis, for political reasons, and not for scientific. Such eugenists do not want the unemployed to multiply because it is the taxes of the rich that will have to feed them. They are opposed to trade unions, they say, because they, the unions, protect the weakling which, correctly speaking, means that they raise the standard of living of the workers and are a limitation upon unhampered exploitation. Eugenists breed racial hatred to confuse political issues and to defend national and colonial oppression. With unabashed impudence they claim to demand sterilization for the sole purpose of saving humanity from the misery of disease, deformities, incompetence and what not, and yet find nothing but approval for an economic system which brings economic, social and cultural misery to the vast majority of mankind. Obviously their sudden solicitude is a bad omen.

There is no doubt that many diseases are inherited and that in a free and classless society their spread should be prevented by sterilization. There are indications also that some forms of feeble-mindedness are inherited, and allowing feeble-minded to breed would definitely spread the gene for it through the population, which, of course, is undesirable. However, a great deal of genetic research has yet to be done before we ascertain the real genetic nature of the detrimental characters of men. We must not permit the unscientific blabber about the Jukes and the Kallikaks influence us to believe that human genetics can be studied by means of the gossip employed in those tales. It should be obvious that we cannot say anything about human genetics until we control the environment as a variable. Unless we control the environment so as to give each child the best our civilization, our inventiveness and our progress have to offer, we cannot say much about its real genetic makeup. People whom eugenists claim today as victims for sterilization because of alcoholism or even real antisocial tendencies, have been shown to be rehabilitated under proper care and social education. It is not the child or youth guilty of stealing that has to be punished but those responsible for the conditions that force children into such a state. This is true socially as well as biologically.

It should be pointed out that sterilization at best is not effective. Most of the harmful characters in man, that is, the few that have been studied, are recessive. In can be shown mathematically that in any population in which some recessive gene is present, the vast majority of individuals showing the recessive character will come from normal parents that are heterozygous for the recessive. About ninety percent of all genetically feeble-minded individuals come from normal parents, each of which carried the gene for feeble-mindedness in the recessive state. It has been calculated that if every feeble-minded person were sterilized, the number of feeble-minded would be reduced to one-half in two thousand years. Obviously, under present conditions, favoring sterilization is not worth the risk. The prominence of medical people and their preponderance on all sterilization boards both here and in Germany is an added indication of the unscientific objective of these boards since it is not the medical aspect of the case in question that has to be determined but the genetic one. As was pointed out before, no records of human heredity are either complete or reliable. Only competent and honest geneticists are eligible judges and they are all agreed that our study of the heredity of man has hardly begun. Eugenists with the usual trickery of political agents take advantage of ignorance or insufficient knowledge to confuse the issue and twist it for the benefit of those whose interests they defend.

Eugenists also talk about raising the biological level of society. No geneticist would ever bother with such a stupid statement were it not for the social menace of all superiority notions which makes it imperative to expose the folly of each eugenic argument. Raising the biological level in man is a meaningless slogan. Man has thousands of genes, many of them defective, present in hybrid, that is, heterozygous condition. There can be no uniform homozygotes in man because of random mating and outbreeding. It is therefore possible for any two, not only normal, but even highly gifted individuals, to produce either mentally or physically defective offspring. In fact the chances of two genetically well endowed individuals producing equally endowed offspring are very slight and seldom if ever occur. We sometimes do find the offspring of a great man figure in one outstanding capacity or another. As a rule that is due to social influence and prestige rather than heredity.

In conclusion, it should be stated that upon considering the arguments of the eugenists we find the very contrary of their claims to be true. We find that anyone concerned with improving the lot of humanity must work for a better social environment, for better living conditions for each human being, for free access to all human inventions of culture and comfort and for the abolition of an oppressive economic system which keeps man from enjoying the results of his ingenuity and from giving expression to whatever biological capacities he may have within him. Besides, only when the environment is controlled can we claim to know the real biological nature of man and the real percentage of gifted individuals in various districts, nationalities and communities. Only then shall we be able to compare any groups we choose and say with honesty and intelligent responsibility that one has a higher percentage of specifically gifted individuals than another and so forth. Biologically there is little we can do now, or ever, for that matter. Man is such an outbreeding animal that he is heterozygous for most of his genes. As was pointed out before, there is no possible way of securing better biological offspring under such circumstances. A "pure race" in a genetic sense, a homozygous race, can come only from brother sister matings, which we know to be detrimental in man because they bring out more harmful than good genes. Heterozygosity in man is inescapable, and little can, therefore, be done by way of avoiding the appearance of unseen, dormant characters, harmful in nature. Socially and environmentally, however, there are worlds of possibilities and hope ahead.

CHAPTER X

Biology and Social Structure

There are many people who claim that although they realize the need for social change, for the abolition of exploitation, oppression and all the social evils that go with them, they believe, nevertheless, that capitalism is in accordance with human nature, while socialism is not. Socialist society, they say, is based on an idealistic picture of human cooperation and will never be realized because of the essential selfishness of man, his meanness, envy, wickedness, hatred of others, etc. We have seen previously that it was on the basis of such popular misconceptions that Freud postulated his possession-aggression instincts, and homosexual rivalry, which among other things bring about wars, deep-seated hatred for one person or another, either father or mother or both, or members of the same or the opposite sex, etc. Freud finally summarizes his orgy of hatreds in his statement that every individual is an enemy of society and finds all culture and civilization an oppressive, enslaving imposition.

Let us consider the relation of the individual to others and to society as a whole. It is said that man is selfish. If by selfishness we mean the desire to satisfy one's needs at all costs, then surely man is selfish. Through sheer biologic necessity an animal, a human child, starts life by being aware of itself only. An animal is a biological organism, which means that it feels pain when *its* sense organs of pain are stimulated, it feels hunger when *its* stomach is empty, feels lonesome when *its* and not somebody else's position happens to be lonely, etc. Hence, awareness of one's existence is an inseparable characteristic of a living organism, if awareness is understood as defined above. Similarly, the satisfying of desires is a phrase designating that behavior which all animals show when they are stimulated in a particular manner and are made to behave accordingly.

Selfishness, then, in the sense of satisfying desires is a phenomenon we must accept as animal behavior, as natural and inevitable. No doubt primitive man acted at first like any other animmal. When he needed one object or another he would take it if available regardless of whether some other person had labored for many days to get it and was just about ready to utilize it. When confronted with resistance he would attempt to subdue his opponent by force. He would even learn that the best way of getting what he wanted was by hitting the owner over the head and getting him out of the way.

Experience, however, is a mighty teacher whose lessons can be resisted by no human being even though some learn faster than others. Man found out soon enough that he could not continue his practice of satisfying his desires in the easiest possible way. We take it that man always lived communally by the nature of the family and the need of shelter and because of the early lesson man learned that he could conquer elemental and organic hostile forces best by cooperative efforts. There may also come in as a factor the psychologic necessity for companionship. Be that as it may, through satisfying his desires by the simple and direct action method described, he found that he could never be sure of his own safety and that he could never tell when another individual would not try the favorite method on him. For his own protection then, man discovered that the crude way of satisfying his desires was not the easiest in the long run, and was far from being safe. Consequently, the community got together and established communal laws the practice of which was bound to benefit every member. We all know, of course, that this law-making was subsequently utilized by a group of people for their own benefit and against the interests of other groups in the community. With the coming into existence of classes, law-making becomes a class tool. In a classless primitive community, however, the making of laws was in the hands of the entire population and each law was a scientific, social lesson, taught by experience and necessity.

It was in this manner that social organization evolved and took shape. Society was not the enemy of the individual but, on the contrary, the only weapon each individual had for attaining that which alone he could never attain. Social organization is the most effective way of satisfying the individual's needs and desires. Such statements as are made by Freud, namely, that society is the enemy of the individual, and that progress as represented by the introduction of soap, tooth paste, clothing, sewers, medicine, learning, etc., was adopted by man only at the cost of suppressing many instincts, must be classified as wild hallucinations and disregarded as such.

Knowledge of the relationship between the individual and society as it took shape with the evolution of the latter, is of utmost importance to any social philosophy. Only by bearing that in mind can we correlate biology with social organization, and see the role played by each in the process of social development.

We have considered the biology of an individual, namely, the genic basis of an organism, the methods of studying it and the mode of functioning of a given gene. Let us now survey the biology of any social group,—a stock, a nation or a community.

It was pointed out previously that if we make a scale of the gradations of any particular capacity in any community and determine their distribution, we will get the population distribution curve. On the other hand, we see that whatever new invention is produced, demanding a particular capacity, a particular skill, any community seems to have a group competent of doing the task. That group, too, will show the usual distribution. To cite an illustration: Should tennis, piano playing or genetic research be introduced and developed in a country or a community where neither had ever been practiced, it will invariably be found that a few individuals will have real innate capacity in that particular direction, a few others will be hopelessly useless, while the majority will vary around the average.

The fact that we obtain a distribution curve for each capacity, an old or a newly established one, leads to the general conclusion that the human species has within its genetic constitution genes for all possible capacities. These genes are multiple for each capacity and inevitably give different combinations, which account for the distribution of variations in skill. Experience proves that any human community we may choose will contain a certain percentage of individuals especially gifted in one direction or another, with the vast majority capable of developing average skill in any task, with slight advantages in one or another.

It is this type of evidence that forces us to conclude that so far as capacities and temperament are concerned, in other words, what is referred to as mental or behavior characteristics of man, no significant differences in their occurrence or distribution have as yet been detected in different human groups. We find that within the limits of error of distribution, taking into consideration size of sample, accidental variations, etc., any groups we examine will have about the same distribution curves for technicians, poets, scientists, engineers, aviators, divers, singers, specific athletes, etc. Of course, after computing the distributions for two groups we may find, let us say, that the number of exceptionally gifted story tellers, their degree of excellence determined by our own arbitrary standards, in Turkestan is 1.3% while the figure for the same capacity in Bulgaria may be 1.2%. It is then statistically possible to determine the significance of the difference. The result of such calculations will tell us how much justification there is to the famous enunciations that provincial philosophers indulge in, namely, that the French are frivolous, the Germans, romantic, etc., etc.

What is relevant at this point is that biology provides every human group with a wide distribution of kind and degree of capacity, present in fairly equal percentages in all human groups. It is for us to examine next how this biological variation harmonizes with the needs of society.

It seems quite apparent that it is precisely this biological variation which makes social life possible. Society has a vast array of needs and can utilize every capacity by making it socially useful. The more developed society becomes, the more complex, the better able it is to find a suitable place for every individual, in harmony with his potentialities, tastes and tendencies.

It is a sign of arrested development to "be proud" of one's biological makeup. No individual has anything to do with it and one's genic composition is only the product of a chance meeting of a particular sperm with a particular egg. On the other hand, we can easily see that from a social point of view all members of society, so long as they perform useful work, must be considered equal. We cannot classify people according to the importance of the job they perform, since it would be hard to suggest a scale of importance. Are the baker and the water carrier the most essential members of society, or the midwife and the singer, etc.? We can only state one thing, namely, that so long as an individual performs a socially useful task, he is a member of society on a par with anyone else doing socially useful work. Biology plays a role here only insofar *as it decides the nature of the socially useful work* a given individual should perform, whether he should work as a mechanic, a teacher, an organizer or a cook. It should be added that our discussion of the distribution curve indicates the realization of the fact that some genetic types are rarer than others and are therefore less easily replaced.

Many people who become superficially acquainted with the facts of genetics and the significance of heredity, raise the bogus of the "inequality of man" as an argument against democratic ideology in general and against the aim of a classless society in particular. They ridicule the idea of social equality as egalitarianism and then proceed to prove that biologically, people differ. We have shown how inane such reasoning is, and that biological differences lead no more to social inequality than the presence or absence of pigment in skin is an indicator of intellectual integrity, or the possession of blue eyes and blond hair indicate courage and sobriety.

It is remarkable how fully aware of this dialectical interaction was Karl Marx when he wrote, "Each according to his capacity, to each according to his needs," about eighty years ago. While many "reputed" philosophers and scientists today, with so much information available on the subject of genetics and social evolution, remain hopelessly muddled on this point, Marx realized that individuals differed in their capacities, and that whoever performed socially useful work deserved from society the satisfaction of his needs. No better scientific summary could be made of the facts of biology and of social organization and of the relation between the two.

While two decades ago the issues raised in this chapter could be considered by many individuals who were philosophically either incompetent or dishonest, as "purely theoretical," this meaningless argument can no longer be given. The planned reorganization of society and the construction of socialism in one-sixth of the world, in the U.S.S.R., have brought to the fore invaluable lessons to the student of human behavior and society. It has supplied mankind with incontrovertible evidence of the truth of the conclusions reached above.

The building of a classless socialist society in the area that was known before the revolution as the Russian Empire has liberated a number of oppressed nationalities who were used by Czarist philosophers as illustrations of "lower races," "inferior types," etc. Having achieved their freedom when the Bolsheviks came to power, these liberated nationalities were subsequently aided in improving their economic and cultural environments. No sooner were these environments brought to a level where the people were no longer hampered and suppressed in their development, than the real capacities normally latent within any population came to the fore. It so happens that the distribution of all capacities observed in the more free and developed countries were not only the same for the erstwhile oppressed groups but were slightly higher. The difference is due, however, to a psychological factor and not to biology. Because as an oppressed group they were not allowed to study certain occupations, the intensified desire to obtain their rights magnified their wish to follow the forbidden studies and occupations. Also, the very act of liberation gave impetus and added vitality to all artistic and cultural efforts.

As new scientific and cultural occupations were introduced to these liberated nationalities, it was found that the poor shepherds, peasants and workers oppressed for centuries, contained among them the same number of biologically endowed poets, physicists, tennis champions, aviators, inventors, teachers, etc., as any other group with a hundred or two hundred years of industrial development behind it. It made little difference whether these people had ever heard of those occupations before. With proper training and experience their innate capacities of whatever nature or degree of skill, came to the fore.

Planned and organized construction of a national industry on a scale unthought of in the history of man, proved beyond a doubt that every person who performed useful labor was a social equal to anyone else, since all were equally needed in the building of society. While unequal remuneration still exists in the U.S.S.R. it is practiced only as a transitional measure of great value in operating for its own destruction by hastening the construction of the ultimate goal of a Communist society where the above quotation of Marx will be a reality.

The monumental events in the Soviet Union prove what geneticists had predicted on analytical grounds, namely, that external biologic variations such as skin or eye color, height, color or structure of hair, shape or thickness of lips, etc., etc., have nothing whatever to do with mental capacities or general cultural tendencies. Under imperialist rule it was difficult to prove this point conclusively, because the continuous oppression of the colonial nations of the "colored" varieties did not permit an environment of free development. Now, when the Soviet government makes all efforts to supply precisely such an environment, genetic analysis is possible. Because the Soviet Union removes all hampering forces in the environment and allows the free and fullest development of the best the individual possesses, it supplies, for the first time in the history of the human species, real data for genetic and social investigation of man.

Our own analysis of human nature presented in a preceding chapter also finds ample verification in the lesson of the events in the Soviet Union which is today indeed the only scene of man in the making, a man of real culture and education, unpolluted by greed for wealth and for blood, by exploitation and oppression of others, by race and national hatred, by careerism and bigotry. When these barbaric remnants are replaced by a social philosophy of sound, scientific values, it is indeed inspiring to see man as he really is, master of nature and builder of an enlightened society undisturbed and unbled by an armed parasitic class. The irrefutable results prove that all talk about "human nature" and its possession-aggression instincts is simply manufactured blabber of the hired servants of imperialists and bankers who resort to any practice in their frantic efforts to stave off their inevitable end.

The educational system of the U.S.S.R., with its idea of polytechnical training and testing, is the only intelligent consequence of the biological fact of genetic variation in capacities and temperament. The child is exposed to and taught a number of key trades so as to find out in which general direction it shows most skill and inclination. It is of value in shaping the child's mind as well as in indicating to the supervisors the lay of the land. The child is subsequently permitted to specialize in that trade or field of work for which it is best adjusted by virtue of competence, choice and temperament.

It is not a question of extolling here the courage, clarity and achievements of the philosophy that led to the formation of the Soviet Union. As students of heredity and behavior we are dutybound to see objectively the facts of the case and evaluate conditions that aid genetic analysis or interfere with it. Because we deal with human behavior we are also dutybound to examine social environments and see which are in harmony with fundamental human conduct and which distort and pervert it. Our scientific attitude forces us to disregard politics and view the events in the Soviet Union in their true light. This leads to the realization that a world of new relationships is being revealed to us in the sphere of human behavior and the nature of the effect upon it of various social influences. The significance of the Soviet stage lies in the fact that the thorough social and economic changes are accompanied by changes in practically every sphere of human conduct.

In conclusion it should be noted that most of the ideas examined or discussed in these pages deal with current situations and serve only as beginnings for broader philosophical analyses. The reader is urged to make as many applications as possible of the generalizations outlined here, because it is beyond the scope of this book to include all questions that may arise. This book will have performed its function if it serves not only as somewhat of a source of information but particularly as a guide and stimulus to further inquiry into biological and social thought and investigation.

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